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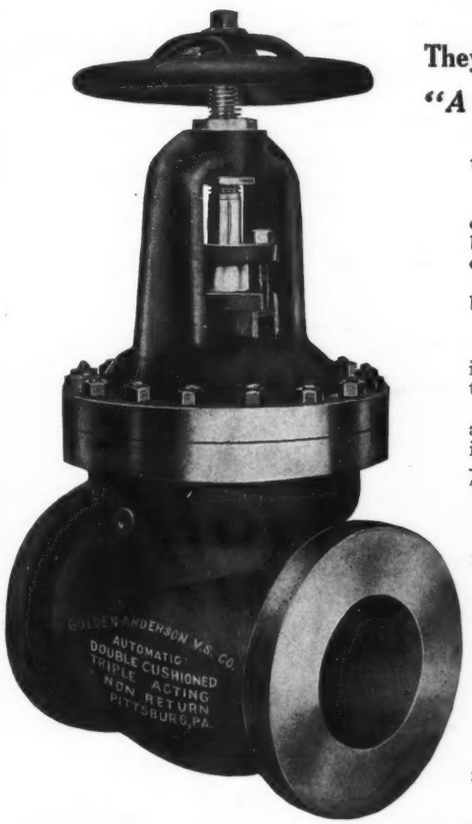


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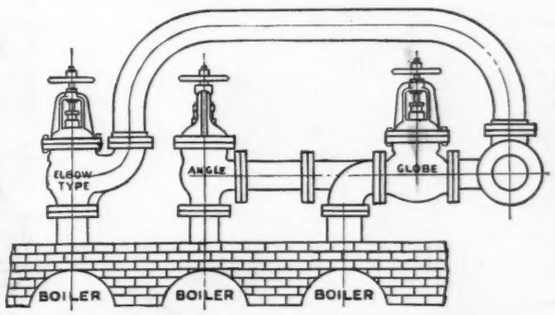

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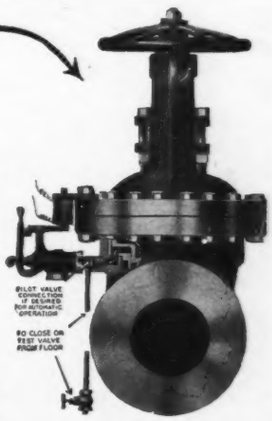


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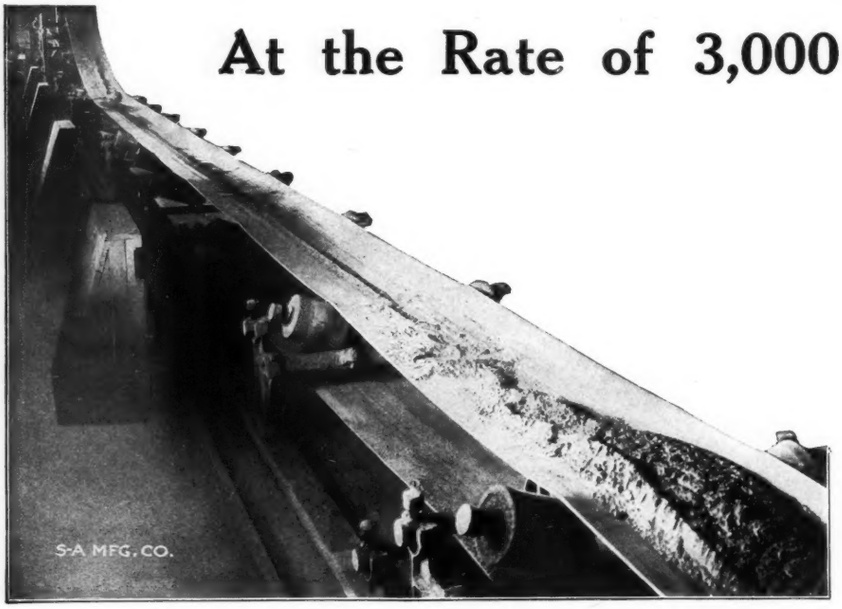


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Engineering and Mining Journal

VOLUME 101 APRIL 8, 1916 NUMBER 15

# The Gilman Cut-and-Fill System of Mining

By Robert H. Dickson*

*SYNOPSIS—Gilman cut-and-fill system devised locally to replace shrinkage stoping, which was less safe under the circumstances. Principal characteristic is the mining of 10-ft. inclined slices. Orebody to be amenable to this system must be able to stand without support for the short time required to mine and fill each slice.*

The Gilman cut-and-fill system is used quite extensively on the large sulphide orebodies of the Junction and Briggs shafts of the Calumet & Arizona Mining Co., Bisbee, Ariz. Only orebodies that are firm and will stand without timber are mined by this method. This cut-and-fill system was devised by Oscar Gilman, mine foreman, and Fred Sandtner, shift foreman, to take the place of a shrinkage-stope method, which was considered less safe under the circumstances. This system is used with various adaptations, so as to be applicable to very differently shaped orebodies. Essentially, it consists of blocking the ore out into sections 40 ft. wide and mining each section by alternately taking 10-ft. incline cuts from the back and then filling with waste. In this way the back of the stope is never over 10 ft. above the working floor, allowing any slabs in the back to be easily caught up with stulls. Alternate or consecutive 40-ft. sections are mined, so that the width of the back that is unsupported will never exceed 40 ft. at one time.

TOP OF ONE OF THE SLIDES IN THE GILMAN CUT-AND-FILL SYSTEM

The exact method of blocking out the ground preparatory to stoping depends on the shape of the orebody. With the larger bodies the ground is blocked out by running, from a main crosscut, parallel crosscuts at 40-ft. centers to the limits of the orebody. Vertical raises are driven off these crosscuts, near the intersections of the main crosscut or at some multiple of 50 ft. from it, usually. These crosscuts and raises serve as the first step in stoping. The raises are run up to the level above, where they hole into a crosscut and provide a means of filling the stope later on. Fig. 1 is a plan of the orebody showing crosscuts and raises. With narrow deposits only one crosscut, passing through near the center of the orebody, is necessary.

After crosscutting, the next step in stoping consists in shooting a little ground off the side of the crosscut so as to accommodate the temporary timbers (shown in Fig. 3) and to make headroom enough for men to work above. These sets are placed at 5-ft. intervals along the drift. These temporary timbers are set in place merely to catch the ore that is broken in placing the regular stringer sets and thus lessen the amount of shoveling. Regular 4x10-in. lagging, 5 ft. long, which later serves as flooring, is used as temporary posts. One of the regular posts 10x10 in., 8 ft. 10 in. long, is used as a cap. The temporary sets are easily and quickly set up and taken down. When in place they will allow a 30-cu.ft. car to pass under them. Lagging, 4x10 in., is placed across the sets, except for a space 12 in. wide running lengthwise with the track, which serves as a chute mouth. This opening is covered with loose 2x10-in. plank 2 ft. long, placed crosswise over the lagging. A 2x6-in. strip is nailed lengthwise with lagging, at both ends of the row of plank, to keep them in place while blasting. As the ore is broken, it falls to the floor of the temporary set. Enough

*P. O. Box 1455, Bisbee, Ariz.

ore is shoveled off one of the short planks, so that it can be taken up, allowing the ore to fall through the opening into a car below. Then each successive short plank is removed by prying it up with a pick or bar, for the same purpose.

When sufficient ground is broken, stringer sets (Fig. 2) are placed in position above the temporary sets, which are then removed. A stringer set consists of a 10x10-in. stringer 18 ft. long, set up over two 10x10-in. posts, 8 ft. 10 in. long. A 6x10-in. block, 2 ft. long, is placed on top of posts under the stringer. To block the stringer to the next one in place 4x6-in. spreaders are used. A floor of 4x10-in. plank, 5 ft. long, is laid on top of stringers. Chutes are placed in every other set on each side of the crosscut.

Starting at the end of the stringers, the ore is then broken on both sides of the stope to make room for the incline sills. These are 10x10-in. stringers, 14 ft. 2 in. long, set on a little over a 30-deg. incline. A 4-in. plank floor is laid on these and serves as a slide for the broken ore to run into the chutes. It also acts as a mat between the gob (which is later introduced) and the ore below, which is mined from the lower level. As the bottom of the whole width of a 40-ft. section is timbered, mining is started with the cut-and-fill system. A raise has already been run to the level above, which is used while filling the stope. The first 10-ft. cut is taken from the back across the whole width of the section, from 30 to 40 ft. on both sides of the raise. As it is possible to drill a large number of holes, the tonnage per man is very high. A few larger boulders are broken, which must be drilled with a plugger machine and blasted. All the ore broken runs from the slides into the chutes. The back of the room, made by taking out the first slice, is usually 10 to 12 ft. above the stringers.

When the ore is all withdrawn after the first cut, waste is run in from above through the raise until it forms a cone reaching to the back of the stope. The gob pile is then evened off on the sides so as to have a triangular cross-section, instead of a cone, as shown in Fig. 5. Sills of ordinary 2x10-in. plank are laid horizontally across both sides of this pile, and a 2-in. floor is laid on this, making two slides sloping on a 40-deg. incline from the center of the raise to the floor on the stringers. All subsequent cuts are taken off the back, parallel to these slides.

As the waste tends to get higher than the ends of the incline sills, 10x10-in. stulls, usually 12 to 15 ft. long, are stood up vertically at the ends of the inclined sills, as shown in Fig. 2. Gob lagging is nailed to the inside of these, which serves to keep the gob away from the ore, thus facilitating mining the next section without mixing with waste.

After the slides are ready, a second cut is taken off the back. Work is started above the bottom of the slides on both sides of the raise, and a 10-ft. cut is carried upward to the raise, parallel to the slide, across the whole width of the section. All the ore is not removed as soon as broken, and hence a little tends to accumulate on the slide, which gives the miners a footing while breaking the ground higher up. The ore is then all withdrawn, and the floor, together with the sills, is taken up, preparatory

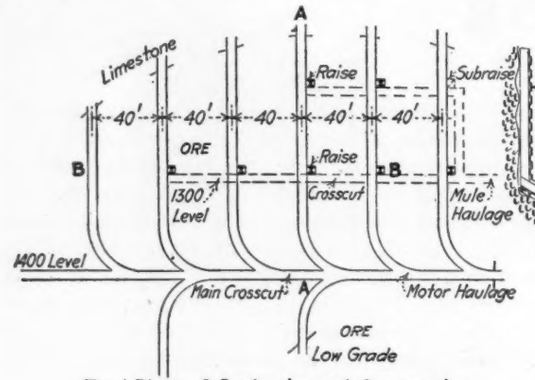


Fig.1 Plan of Orebody and Crosscuts

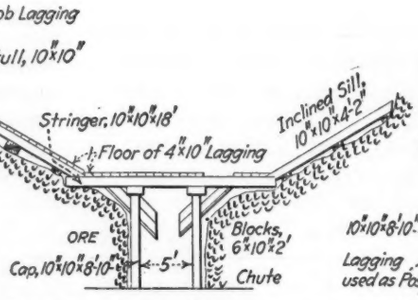


Fig.2 Regular Section Timbers

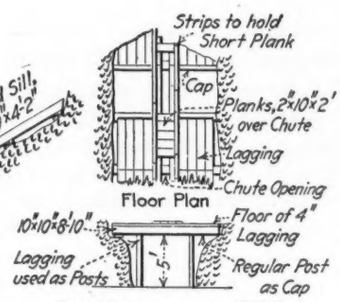


Fig.3 Temporary Sill Set

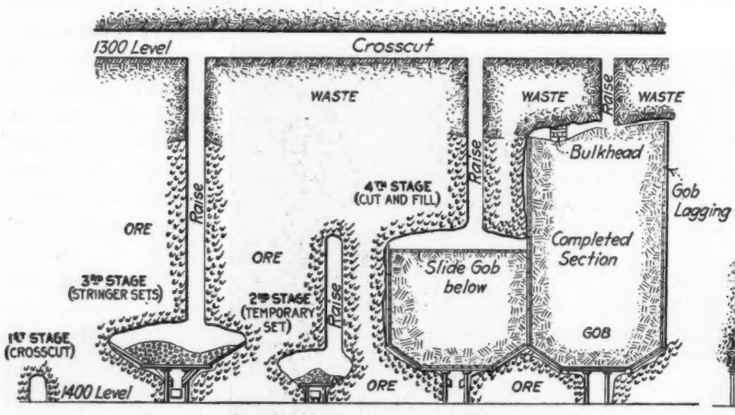


Fig.4 Vertical Section through Stope, B-B

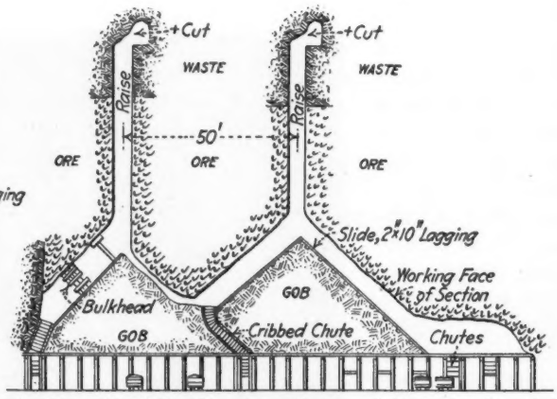


Fig.5 Vertical Section, Lengthwise of Stope, Section A-A

DETAILS OF THE GILMAN CUT-AND-FILL MINING SYSTEM

to the second fill. Waste is introduced as before, forming a cone reaching to the highest part of the section. This pile is made into two flat inclined surfaces on which 2x10-in. sills and a 2-in. floor are laid, as before. Enough room is always left between the waste and back of stope to permit this floor being laid. This section is now ready for a third cut.

When the waste cone extends to the back of the ore, a second raise is necessary to fill the stope. In case another raise is not already there, a subraise is run from the back of the stope, about 50 ft. horizontally from the first one, to the level above. This raise is then the center of cut-and-fill operations. In mining a long section, several raises in succession are the center of cut-and-fill operations. Where the ground will permit, cuts may be taken off two raises simultaneously, as in Fig. 5. As the lower ends of the slides get above the stringer floor, cribbed chutes of 4x10-in. lagging are carried up through the gob to the bottom of the inclined slides. A grizzly consisting of two 8x8-in. timbers is usually placed over the top of the chute to prevent extra-large boulders from rolling into it.

In this manner a whole section is mined by taking out 10-ft. inclined cuts and filling with waste, until the back of the orebody is reached. Stulls with headboards, or a bulkhead if necessary, can be thrown against the back to catch up any bad slabs. Long bars are used to bar down any loose ground. Vertical stulls and gob lagging are carried up on the sides of the section as necessary.

### Method of Handling Gob

As the ore is removed up to the waste and the gob will no longer run in to fill the open spaces between the top of the pile and the back, it is shoveled in by hand until it is snug against the back, for which it provides a substantial suport. In special cases, where it is impracticable to use gob, bulkheads made of old timber are placed between the top of the gob and the back.

In mining a large orebody, alternate sections are usually taken out and afterward the section between is mined. Sometimes sections are worked progressing across the orebody, starting at one end and working toward the other. The sections vary in length up to 200 ft. Where they would be much longer than this, mining is carried on at both ends, as if they were two separate sections, the pillar between being subsequently removed.

The ore is drawn direct from the chutes into 30-cu.ft. cars and thence taken by electric motor to the station pocket. Skips are used to hoist the ore. The even-numbered levels (1,400-1,600) are the main haulage levels and have electric-motor haulage, while the odd levels are more the prospecting levels and have only mule haulage. The gob used to fill the stopes consists of limestone, broken in development work.

The Gilman cut-and-fill system is a very cheap method and affords a degree of security that the old shrinkage stope and glory-hole methods of mining lacked. The back of the stope is always within reach of the miner, where he can bar down loose ground or throw up a stull against the back if necessary. As the ore is taken out in successive cuts, the back does not have time to slack or become slabby. This method can be used on almost any shape of deposit. Besides being used as herein described, it is applied, with as good results, to an orebody 30 to 40 ft. thick with a limestone foot wall dipping about 45 deg., where the length of the section is made parallel to the strike of the lime. All drilling in the sections is done by stoping drills with water attachment, except on starting, where timber is being placed. Here plugger and chippy drills are used as well. The various slides eliminate practically all the mucking. The gob requires no handling except in laying the slides and in keeping it snug against waste in back, after the ore has been taken out.

## Accidents Classified by Mining Methods*

Inasmuch as systems and methods of mining differ, some methods must necessarily be more dangerous than others.

Data relating to the classification of mine accidents, based on specific systems of mining, are lacking, and in order that the comparative risk in the different methods might be ascertained, the report cards sent to the operators at the close of 1914 requested that the method of mining be reported with the statistics of accidents. With these reports as a basis, the bureau has been able to select the returns from 258 mining companies, representing about 75% of the metal-mining industry, whose records appear reasonably complete. Reports from companies whose data were not complete in all details were omitted in making this study. The figures given herein, therefore, include the actual number of men (75,453) employed underground and in openpit mines, with the corresponding number of accidents for each group.

In the tabulation of accidents with reference to the mining method, the employees around shops and surface works have been eliminated, as well as the corresponding number of accidents. There seems to be no reason why the hazard at the surface plant of a room-and-pillar mine should be any different from that at a mine where overhand stoping is the chief method employed.

In one mine the principal method of mining may be overhand stoping; but to a certain degree there must necessarily be some underhand stoping, a small amount of filling and some room-and-pillar work. The methods as classified have been grouped, therefore, according to the principal method used, and in the majority of the cases represent 80 or 90% of the total work at the individual properties. For the purpose of studying the mining risk, the returns received from the operators have been divided into six groups, representing the principal mining methods, as follows:

1. Overhand stoping confined to narrow veins.
2. Overhand stoping confined to wide veins and large orebodies.
3. Room-and-pillar method (without timber).
4. Caving systems and their various modifications.
5. Openpit with steam shovel.
6. Openpit without steam shovel.

These different methods have been developed to work different types and classes of orebodies, and inasmuch as orebodies are fixed and definite, it is necessary to modify mining methods to meet the requirements of each orebody if the ore is to extracted at minimum cost and with least loss. Safety should be the first consideration, although

*Excerpt from Technical Paper 129, "Metal-Mine Accidents in the United States During 1914," by Albert H. Fay, Bureau of Mines.

many other factors have to be taken into account in laying out a mine.

Fig. 1 shows fatality rates compared by causes of accidents and by mining methods. Fig. 2 shows a similar comparison for injury rates.

### Overhand Stoping (Narrow Veins)

The figures covering overhand stoping in narrow veins are made up from the reports of 64 companies in 12 states, employing 9,177 men actually engaged in mining operations (surface shops excluded). This group includes chiefly gold mines in California, Colorado and Nevada and some copper mines in Michigan. The width of the vein, roughly, is less than 15 or 20 ft. The principal mining method was overhand stoping, a minimum amount of timber being used as stulls and props. Combinations and modifications of overhand stoping with a small amount of underhand stoping, waste filling, cutting and

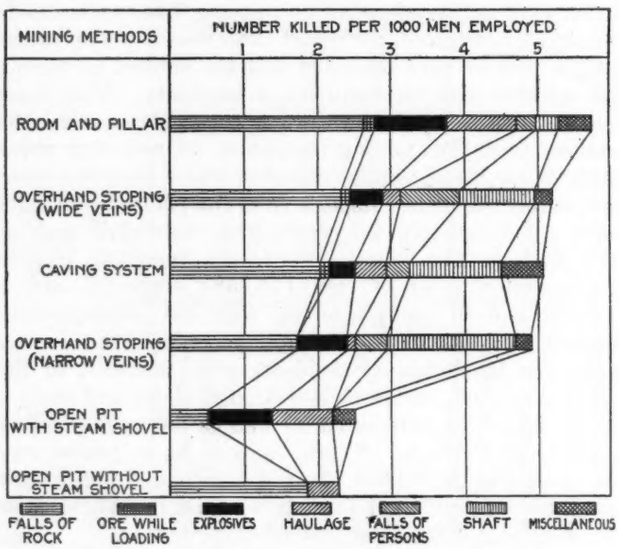


FIG. 1. FATALITY RATES COMPARED BY CAUSE OF ACCIDENT AND BY MINING METHOD

filling, shrinkage and a few other minor modifications are included.

Of the 64 companies making up this group, there were four operating Arizona copper mines, one an Arizona gold mine, and two Nevada gold mines, all in narrow veins, that reported the use of some filling method. One New Jersey iron mine and one Tennessee copper mine reported underhand stoping. Six of the 64 companies use underhand stoping to some extent in connection with overhand stoping. Eight California gold mines and three Nevada gold mines were included which reported overhand stoping, both with and without timber.

Of the number of men employed in this group of mines, 45 were killed, 511 seriously injured and 2,617 slightly injured, the fatality and injury rates being, respectively, 4.90, 55.68 and 285.17 per 1,000 men employed.

The figures for overhand stoping in wide veins include the returns of 61 companies, representing mines in 14 states and employing 25,981 men (excluding surface shops). The mines included in this group are those in which the orebodies are wide and massive and in which much timber is used as square-sets, drift-sets and cribbing. There are also included mines in which slight modifications of this method, as shrinkage stoping, filling and some underhand stoping, are used. These are largely Arizona, Michigan, Montana and Utah copper mines, with a number of Colorado gold mines and a few gold mines in various other Western States. Six of the large Michigan mines reported the use of underhand stoping, especially in opening new ground of uncertain value. Of the total number of men employed, 136 were killed, 1,396 seriously injured and 7,848 slightly injured, giving fatality and injury rates per 1,000 men employed of 5.23, 53.73 and 302.07.

Overhand stoping has a wide range of application and is used extensively in wide and in narrow orebodies, with inclinations ranging from 10° to 90° from the horizontal. As regards safety, overhand has some advantages over underhand stoping, as the men always work close to the roof, so that they can easily test it. In underhand stoping the men sometimes work 50 or 75 ft. below the roof, so that they cannot ascertain its exact condition by sounding. By falling 50 ft., a piece of rock weighing only a few ounces may injure a man.

When overhand stoping is used without timber, the men have a secure scaffolding of ore and waste rock on which to work, and the danger of falling through the timbering, as in places where square-set or other timbering is used, is eliminated. Hence the fatality rate from falls of persons is about one-half as great in mines (narrow

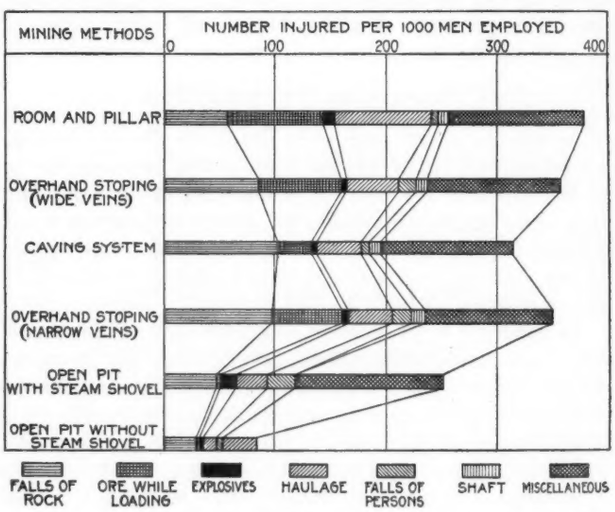


FIG. 2. INJURY RATES COMPARED BY CAUSE OF ACCIDENT AND BY MINING METHOD

veins) using little timber as in those working large orebodies and using a maximum amount of timber.

It is doubtful whether the ore chutes used in working large orebodies are as well guarded as they should be. Usually the chutes are cribbed to the top of the loose ore or rock, but no vertical timbers protrude above their tops, so that conditions for a man falling in are ideal. In square-sets the floors are often in poor condition, with plenty of broken and loose plank and unguarded openings through which a man may fall, even if he is cautious in all his movements.

The hazard due to the use of explosives, however, does not appear to be so great in wide orebodies, probably because less powder is required to break the ore than in narrow, tight veins.

There is likely, however, to be much drill dust in all overhand stoping, as the men are drilling uppers. The

powdered rock falls directly in front of the miner and is intimately mixed with the air he breathes. In underhand stoping it is an easy matter to keep the holes filled with water and thus allay the dust, whereas with overhand stoping a somewhat complicated mechanical equipment is required to accomplish the same result.

The fatality rate for overhand stoping in large orebodies where a maximum amount of timber is used is 5.23 per 1,000, as compared with 4.90 in the narrow orebodies. Although these figures are representative for a single year, not enough data have been collected to warrant drawing reliable conclusions.

### Room-and-Pillar Method

The figures covering mines in which the room-and-pillar method is used represent the returns of 41 mining companies, employing 8,335 men (surface shops excluded). The mines include 22 lead and zinc mines in the Mississippi Valley; 8 iron mines, 5 of which are in Alabama; 6 gold mines, and 5 gypsum mines.

Room-and-pillar mining is especially adapted to sheet-ground deposits lying approximately flat, and little or no timbering is used other than an occasional prop. The roof is entirely supported by pillars of ore 15 to 25 ft. in diameter, left, as a rule, where the roof conditions demand, without regard to regularity. Sometimes the pillars are the poorest ore in the mine and are not recovered, and sometimes, where the ore is of average richness, the pillars are drawn after the rooms have been worked out.

For the successful use of this method of mining, a solid back or roof which can be easily supported is required. In the lead mines in southeast Missouri there is a strong limestone capping, which is so self-supporting that about 85% of the workable ore is extracted, leaving only 15% in pillars.

As would be expected, the fatalities and injuries due to falls of persons are much lower for this group of mines than for the two preceding groups in which overhand stoping methods are employed.

Fatalities and injuries due to explosives are much higher, because large faces of ore are exposed and heavy charges of dynamite are used. These flat orebodies, when mined, leave large open spaces, and the danger from flying pieces of rock and ore from blasts is increased because the men cannot get to proper shelter so readily prior to firing shots. The fatality rate due to explosives is higher in this system of mining than in any other, whereas in serious and slight injuries it ranks second. Accidents due to haulage systems and falls of roof are considerably higher than in any other group.

The total fatality rate in the room-and-pillar mines considered is 5.76 per 1,000, as compared with 5.23 for mines stoping large orebodies and 5.10 for the mines using the caving method.

The data relating to the caving system of mining include the returns of 53 companies operating mines in 9 different states and employing 20,177 men. Of the 53 companies represented in this group, 42 operate iron mines in Minnesota and Michigan, 5 operate copper mines in Arizona, and 4 others operate copper mines—the mines being in California, Nevada, New Mexico and Utah.

Many different names are applied to caving systems, but the principle of them all is nearly the same. A certain system may be employed in different states but be known by local names, as, for example, the name of the mine foreman who introduced it at a mine, after having gained his knowledge of it at some iron mine in Michigan or Minnesota. The methods included in this classification include top slicing, substoping, block caving, pillar caving, etc., and the preliminary work that is absolutely necessary for all caving systems.

As would be expected, the fatalities and injuries from explosives are much lower in this group than in any of the others except in openpit mining without steam shovel. A minimum amount of explosives is used, the weight of the overburden being expected to crush and loosen the ore so that it can be extracted without blasting. The fatality rate for this group of mines is 5.10 per 1,000 men employed, as compared with 5.76 for room-and-pillar and 5.23 for overhand stoping in wide or large orebodies. The fatalities due to falls of rock are slightly less than in mining by room-and-pillar and by overhand stoping. The serious and slight injuries, however, are somewhat in excess, owing no doubt to the fact that while a man is shoveling or barring down the ore in a chute, his foot or hand may be injured by a piece rolling down. Also the miner often works where there is a large amount of crushed and broken timber, so that he receives many cuts and bruises. Timber and hand tools are responsible for 18% of the serious injuries and 17% of the slight injuries in the caving systems of mining.

Fatalities due to falls of rock are 2.08 per 1,000 employed, as compared with 2.35 in large orebodies where overhand stoping is used, and 2.64 where the room-and-pillar method prevails. In most cases the rock has not far to drop, which may possibly account for the smaller number of fatalities in this system.

### Openpit Mining with Steam Shovel

The returns from mines that use the openpit method with steam shovel represent 26 operating companies, employing 9,591 men (surface shops excluded). Of the 26 companies, 15 in Minnesota and 6 in Alabama are iron-mine operators, and 1 each in Nevada, New Mexico, and Utah operate a copper mine, and 1 in Tennessee operates a phosphate mine.

The controlling factors in the choice of this method of mining are the areal extent, elevation with respect to the surrounding country, amount of overburden and depth to which the deposits extend. The steam shovel may be used in handling massive deposits of a wide range of hardness, although it is best adapted for use with those ores that break into fragments readily. Work at these openpit mines is conducted on a scale comparable with railroad transportation, inasmuch as most of the ore is loaded directly by steam shovel into railroad cars operated by standard locomotives. The accident hazard includes many of the dangers to which railroad employees are exposed.

A large amount of explosives is used, and these cause about one-third of the fatalities. Serious and slight injuries due to explosives are also higher in this system of mining than in any other, largely because large quantities of explosives are used and blasting is in open air, so that fragments of rock may fly many hundreds of feet. Although a mining company may be doing all it can to guard against injury from the use of explosives, there is always the possibility of someone passing near-by or perhaps working in an obscure place, unaware of the warning

given previous to the exploding of a large charge of powder or dynamite.

The fatality rate for this group as a whole is approximately one-half as high as in all-underground operations. There seems to be but little difference between the fatality rate in openpit mines with steam shovel and those without the steam shovel, the rates being 2.50 and 2.28 per 1,000 men employed. The steam-shovel mines were operated 275 days a year as compared with 229 days for the other openpit mines. The fatality rate adjusted to a 300-day basis becomes 2.73 for steam-shovel mines and 2.98 for openpit mines not using the steam shovel.

The serious and slight injuries are considerably higher than in the openpit mines without the steam shovel. The difference is largely due to the machinery about the shovel, to the necessity of adjusting and placing the steam shovel and to accidents from railroad operations, such as coupling cars, throwing switches and laying track. The 46 days' excess exposure to the mining hazard should be responsible for nearly 20% of the difference.

### Openpit Mining Without Steam Shovel

As regards the openpit mines without the steam shovel, the returns represent 13 operators employing 2,192 men and include 6 phosphate mines in Florida, South Carolina and Tennessee, 1 iron mine each in Alabama and Michigan, 1 copper mine each in Alaska and Arizona, and 1 gold mine in California in which much of the ore is mined by the glory-hole method.

In the openpit work without steam shovel the ore is blasted down from the bank, loaded directly into small tram cars and dumped into bins or railroad cars. This method of working, however, is becoming more or less obsolete and is being supplanted by the use of draglines or wheel scrapers and, where the deposits are large enough, of steam shovels.

In the matter of safety the figures indicate that the system under consideration is safer than any other, yet the number of men involved is not large enough to permit the making of a definite statement to this effect. The number of days worked per year is less than in any other group, and hence the exposure is less. The method is, however, more or less comparable with quarry work. All of the openpit work is conducted where there is plenty of light, thus giving the miner an opportunity to see conditions as they exist. Furthermore, the air is good and in most cases there is ample room for the miner to keep out of the way of falling material.

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## Changes in First-Aid Contests

A bulletin entitled "Suggested Changes in Rules Governing First-Aid Contests" has recently been published by the Southwestern Mine Safety Association, copies of which have been distributed by the secretary, J. J. More, at Ray, Ariz. Believing that there is considerable dissatisfaction throughout the United States with the systems of judging first-aid contests now in vogue, these rules have been compiled in the hope that they would aid in bringing about a standardization of methods of procedure and judging. The association solicits comments and criticisms on the proposed rule.

Some comments on the rules have been made by Duane Rebstock, of Ray, Ariz., and published in Bulletin No. 15 of the Arizona State Bureau of Mines, Tucson, Ariz.

## Hydrocarbons for Flotation

One of the recent developments in flotation is the use of flotation agents made from the combination of sulphuric acid and hydrocarbon oils. The use of such products for frothing purposes is covered by United States Patent 1,170,665, granted on Feb. 8, 1916, to E. H. Nutter, of San Francisco, and assigned by him to Minerals Separation American Syndicate (1913), Ltd., of London.

According to a description of the discovery it is set forth that it has been found that there are a number of hydrocarbons, particularly unsaturated hydrocarbons, which when treated with sulphuric acid form compounds suitable for use as frothing agents in the froth-flotation processes of ore concentration, and with some ores these agents have advantages in forming cleaner concentrates or more stable froth. These products are obtained in the treatment and refining of hydrocarbons such as petroleum, kerosene and gas-tar, and particularly in the refining of their distillates. A typical example of such products is known as acid sludge, and it has been found, for example, that acid sludge produced by the sulphuric-acid treatment of kerosene obtained from California petroleum is highly advantageous as a frothing agent.

In the employment of the agitation-froth process difficulties are frequently encountered when the ore pulp contains very fine gangue slimes or colloidal gangue slimes. This is frequently the case with copper ores, and the use of the compounds produced by the action of sulphuric acid on hydrocarbons of the type described has proved especially advantageous in such cases. Excellent results have been obtained, for example, by using these frothing agents in the subaëration process of ore concentration.

The following is an example of the operation of this process: The material operated was the tailings from water concentration tables in the treatment of copper ore from the Anaconda mines, Montana, and these tailings assayed 2.26% copper. To a pulp containing this material in the proportion of 24% of solids was added 2.3 lb. acid sludge per ton of material treated, 2.3 lb. wood creosote per ton, 0.21 lb. stove oil per ton, 12.7 lb. sulphuric acid per ton of ore. The pulp, heated to 97° F., was treated in a standard Minerals Separation flotation machine, wherein it was agitated to form a froth and the froth was separated. The concentrates assayed 10.1% copper, and the tailings assayed 0.2% copper. It is further found that these substances produced by the action of sulphuric acid on hydrocarbons are in many cases more effective as frothing agents when they have been standing for some time or when they have been mixed with water for some time, and the invention includes the use of such compounds in these conditions.

The invention may be used in conjunction with any of the known or patented processes of ore concentration by froth flotation, either for the separation of the metalliferous constituents of an ore from the gangue or for the separation of different metalliferous constituents from one another.

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**The U. S. Geological Survey Answered 50,000 Letters** of inquiry last year concerning the earth's crust and what it contains. These letters ask not only about the geology of this country, but also about the rocks and minerals of foreign countries. More and more inquiries for information about our mineral resources are coming from South and Central America.

# Antimony in Hunan Province, Southern China*

*SYNOPSIS—The Province of Hunan in southern China is the chief source of the world's supply of antimony. The most important mines are in dolomitic limestone in the vicinity of Hsin-hua in the Hsi-kêng-shan field. World's output of antimony in 1910 was about 18,000 long tons; Mr. Wheler estimates present production at over 40,000 tons.*

It is well known that China has for many years held the position of the world's largest producer of antimony, and the province of Hunan is the chief source of the Chinese supply.

The few brief references to be found in various technical transactions and journals allude in general terms to the deposits of Hunan as "an antimony belt." This, however, is incorrect, as the orebodies are not only of different types, but occur under widely varying geological conditions.

It is not proposed here to refer in detail to the numerous small mines scattered throughout the province, but to describe only the more important producers. The chief of these, from the points of view both of output and grade, is the Hsi-kêng-shan field, which lies 21½ mi. east of the town of Hsin-hua, on the Tzü River, and is generally referred to as the Hsin-hua mines.

### No Igneous Rocks Observed in Hsin-hua District

The geological formation is carboniferous dolomitic limestone, with occasional beds of shale and sandstone; associated with the latter are seams of bituminous coal of inferior quality, which are being worked. The strata lie in gentle undulations, with low angles of dip to east and west. It is remarkable that no igneous rock of any sort was observed in the vicinity of the mines.

The deposit occurs in an up-thrust section of dolomitic limestone having a north-northeasterly strike and a dip averaging 15° in an east-southeasterly direction. The strike fault, which has produced this, can be traced for several miles, and on the line of it, at a distance of about 2½ mi. south of the Hsi-kêng-shan group, a second but much smaller deposit of antimony, of a similar nature is being worked. Faulting is well evidenced by the abrupt scarp that marks the line of reef, by the brecciated country that has been either partly or completely cemented with $SiO_2$ and by the numerous slickensided clay selvages in the workings.

### Best Ore Found in Dolomitic Limestone

The topmost bed is sandstone, which is found to carry some ore at the south end of the reef, where the grade is also lowest; but the ore carrier is essentially a layer of dolomitic limestone underlying this and ranging from 20 to 40 ft. in thickness. This has been faulted and fissured, and the ore is found generously distributed throughout it in seams, pockets and big bunches, for a distance of 2,000 yd. along the strike.

The ore is stibnite, $Sb_2S_3$, oxidized in places to cervantite; its characteristic form is in masses of long radiating or columnar crystals, measuring up to 10 in. in length. It is of remarkable purity, carrying a fraction of a percentage of arsenic and traces of lead and copper.

The entire field is in the hands of Chinese, and along this 2,000 yd. of reef there are about 70 companies and owners operating workings that have reached a maximum depth of about 300 ft. measured on the incline.

### Mining Operations Crudely Conducted

Although surface areas are established by beacons, there is no definite system of underground boundaries. The mines are worked totally regardless of vertical planes through surface boundaries; but a *modus vivendi* is usually arrived at somehow without excessive friction and seems to depend mostly on who was "there first." It is even not uncommon to find one company working immediately above another, in which event the upper is not supposed to let down water on the lower, and it is understood that the lower will reciprocate by not letting smoke into the upper workings. The system of mining is equally methodless and consists of following the ore down and working it out as found, leaving chambers of irregular shape, often of considerable size and entirely unsupported. Add to this the effects of an atmosphere created by an almost total disregard for ventilation, combined with the use of native-made black powder for blasting and vegetable-oil flare lamps as illuminators, and the net result is a situation of almost hopeless bewilderment on which the rays of a powerful acetylene lamp can shed but little light.

All mining work is let on contract, as is usually the case in Chinese mines. The contractor has to find everything and receives about $8.76 per long ton of sorted ore. He pays the miners about $1.05 per month each, plus a bonus according to the profit earned.

The ore is rough-sorted underground and carried to surface in basket loads of 79 lb. or more. It is then cobbed and closely-sorted. The picked ore averages about 60% Sb; the remainder, together with the fines and mine sweepings, is reduced by hand to a size corresponding to ¼-in. or ⅛-in. mesh and is subjected to repeated concentrations by hand in shallow circular baskets immersed in water. The men that do this work become extremely expert and rapid at it; with a few half-turns and a back shake, or two, they bring the waste to the top, skim it off and repeat the process until the material has been concentrated to about 45% Sb.

Owing to the boom in antimony, the waste heaps and dumps are being minutely gone over and their contents graded up by cobbing and concentration, this work being usually left to the "small workers," or poorer people, who sell the product to the mine owner at $8 to $12 per ton.

There are seven local smelting works, two of which are privately owned, the remainder being customs works. These are turning out "crude" only, with the exception of the Mei-hsiang company, which also started to produce regulus by smelting oxide ore in reverberatory furnaces. Their total output had only amounted to about 100 tons,

*Excerpts from a paper presented by A. S. Wheler at the meeting of the Institution of Mining and Metallurgy, London, Feb. 24, 1916, with a few supplemental notes containing recent information supplied by a "Journal" correspondent familiar with the mines of Hunan.

when the Wah Chang Mining and Smelting Co., of Changsha, which held the monopoly in China for the production of regulus, and also had powerful friends at Court, successfully protested against what it regarded as an infringement of its rights by the Mei-hsiang company, with the result that the latter concern was recently absorbed by the Wah Chang company. This monopoly, it should be mentioned, has since been considerably curtailed, and is now in force only within a radius of about 36 mi. of Changsha city. [The Wah Chang monopoly for the smelting of regulus in the Province of Hunan has recently been extended for a period of 30 years by the central government in Peking.—Editor.]

The smelters make an all-round returning charge of about $4 per ton of crude produced and will not accept ore below 40% grade; this, however, is estimated solely by its appearance. The ash is the smelters' perquisite, and the local coal costs $1.32 per ton delivered.

The output of crude from this field is placed at rather over 1,000 tons per month, but in addition to this a few hundred tons of high-grade ore is shipped to Changsha for treatment or export. The cost of carriage from the mine to river, a distance of 20 mi., is $1.25 per ton, and freight by junk to Changsha—270 mi. downstream—is about 90c. per ton.

The total population of Hsi-kêng-shan, which may be regarded as existing entirely on the antimony mines, is estimated at 20,000, and about half of these are directly employed on the mines, floors, or works.

### The Pan-shi Antimony Mines

Next in importance, but coming a poor second, are the Pan-shi mines. These are situated about 25 mi. south of Chan-shi, a small town on the Tzü River. The surrounding country is of a mountainous nature and is composed of sedimentary strata consisting of clay, slates and shales, with occasional layers of quartzite. These have been tilted and bent by a granitic intrusion, producing well-developed joint planes, but have undergone little alteration. The predominant strike of the strata is east, while that of the joint planes varies generally from northeast to north-northeast.

The four orebodies being worked here are all of the fissure-vein type; their strikes range from east-northeast to northeast, and the angles of dip are approximately vertical. The veins are narrow, their average width probably not exceeding 15 in. The filling consists of quartz of interlaminated schist and quartz, and the ore, which is stibnite, usually occurs as a narrow seam hugging the foot wall and accompanied by a strong clay selvage. The payable ore occurs in comparatively short shoots, which have been followed down to depths ranging from 150 to 550 ft. The lowest levels show a considerable decrease in the length of the shoots, though the fissures are still strong and well-defined.

Each mine is run by a contractor. The ore, after being cobbed and sorted to about 30% Sb grade, is bought by the company at $2.37 per ton. In addition, the company also pays a bonus increasing with the monthly output and the footage driven. The contract price paid per foot (5x4 ft.) varies from $2.68 to $9.50. The contractor does all the pumping (with bamboo suction pumps), for which he receives an allowance of from $15 to $50 per month, according to the quantity of water to be dealt with. The company provides drill steel and ore baskets and sells powder, oil and rice at about 25% below market rates. These "allowances" are so adjusted that the miner receives an average wage of about 10c. per day.

There is no smelting plant at the mines. The output, amounting to about 400 tons monthly, is sent to the Wah Chang company's works at Changsha. From the mine it is carried 2 mi. overland by coolies, then floated in half-ton lots on bamboo rafts down a small creek to Chan-shi, and finally transferred into junks of 8- to 10-ton burden, which convey it 100 mi. downstream to Changsha.

The total cost of the ore amounts to about $11 per ton delivered at the works and it goes to supply the Herrenschmidt furnaces employed in the production of regulus.

### Wu-shi Mines Originally Worked for Gold

The Wu-shi mines lie 52 mi. east of Shenchowfu (also called Yuen-ling-hsien) in the mountainous and rugged country dividing the Yüan and Tzü Rivers. The nearest town, Kai-ting-yi, is 3½ mi. distant in a westerly direction.

The country, similar to that at Pan-shi, consists of slates and shales with a few bands of quartzite and has been bent into folds dipping to southwest while the cleavage, or joint, planes are steeply inclined at right angles to this. Outliers of conglomerate, breccia and standstone, of a deep-red color, overlie this series unconformably, with a southeasterly dip of 20°, gradually obscuring it as one travels westward until, at a distance of 15 mi. from the mines towards Shenchow, coal measures consisting of limestones, sandstones and shales are found intervening, the junction between the two latter being probably likewise marked by unconformity.

The deposits are fissure veins following two main directions of strike—north and east—and from the evidence available, the latter appear to be the more productive. They were originally worked for gold; the antimony was an unknown mineral and treated as waste. As the average gold tenor was low and the method of treatment crude, the mines did not thrive, and the Hsi-lu company, recognizing their real value, was able to purchase them "for a song." There are two or three other companies at work, but their output is a negligible quantity at present.

The veins are of quartz with included fragments of slate; the foot wall is regular and well-defined, but the hanging wall is indistinct; the ore is stibnite and is usually present as a seam closely following the foot wall rather than disseminated through the quartz.

### Veins Still Strong at Lowest Workings

In the western workings the vein has been driven on for 500 ft. and stoped out to water level, 130 ft., where it is 3 to 4 ft. wide; in the eastern workings the vein has been worked to a depth of 450 ft. measured on the dip, where it shows in the stopes as a well-mineralized body 3 ft. wide. In fact, the appearance of the vein in the lowest levels of both workings is extremely promising.

The miners work on the piecework system, and are paid $1.32 per month for a minimum of 1,316 lb. of ore per shift; the ore carriers earn about 80c. per month for carrying this to surface; both receive a bonus for excess. Pumpmen are paid from $1.32 to $2.64 per month and work 12-hr. shifts, raising the water with bamboo suction

pumps up 400 ft. of incline in 10 lifts, where other pumps pass it up to the surface.

The ore is cobbed and sorted into two grades, rich and poor, the former carrying over 30% Sb and the latter 20%, and is partly treated in a liquation plant having a daily capacity of about a ton of crude. The waste sorted out is principally quartz and carries perhaps 4 or 5 dwt. of gold per ton; it is sold to the several privately owned mills in the neighborhood, where it is crushed, concentrated over riffle boards and panned; the gold recovered is, however, barely sufficient to support the workers.

Lack of fuel has been the drawback hitherto, but with the recent discovery of coal in the neighborhood, this field is likely to prove a producer of at least equal importance to Pan-shi. Arrangements are in hand for the development of the mines on modern lines and for the installation of hoisting and pumping plant; additional furnaces are to be built to cope with the largely increased output of ore that is anticipated, and the erection of a smelting plant to produce regulus is in contemplation.

Among the numerous smaller producers, the An-hua, Chiang-hsi-lung and Lung-shan mines call for a brief reference. The first named are situated to the west of the Tzü River, about 50 mi. west of An-hua and to the north of Chü-pu. Several veins of a similar type to those at Pan-shi are supplying about 100 tons of 50% ore per month, the majority of which goes to the Wah Chang works. The rest is sold to the Yung-fu Smelting Co., which has recently built some liquation furnaces at Chü-pu, on a small affluent of the Yüan River.

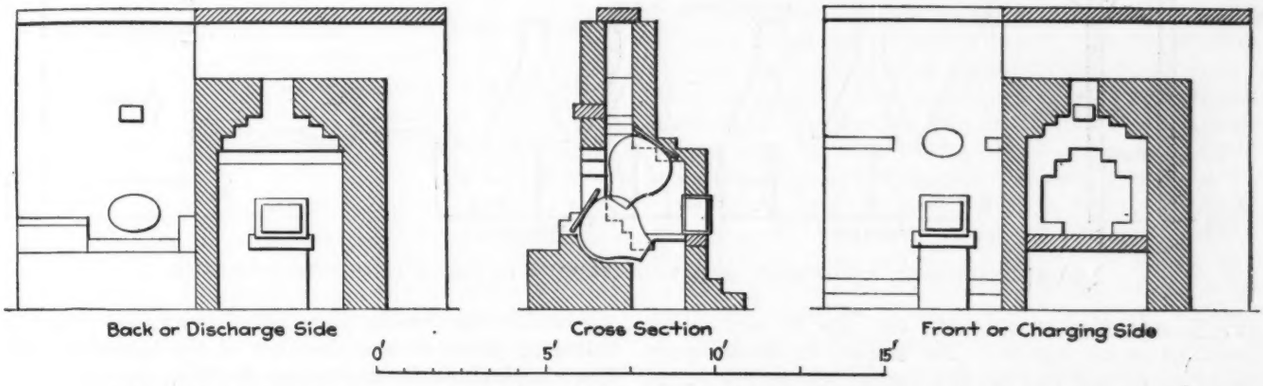
The Chiang-hsi-lung mines, 14 mi. south-southeast of Chü-pu, are on a vein that can be traced for a distance of over 3,000 yd. along a range offering excellent opportunities for adit attack, of which the Chinese appear to take advantage but rarely. . . . The ore supply comes from seams and stringers of mineral in the quartzose portions of the vein. Work has been done at numerous points, but there were only three mines accessible and in operation, of which the deepest workings were 375 ft. below the outcrop. These showed that, not only were the pay shoots short and rapidly contracting, but the vein was also waning and pyrite replacing the stibnite. The picked ore or concentrates are . . . either shipped direct to Changsha or sold to the Yung-fu Smelting Co. at Chü-pu. The total output at the beginning of 1915 was about 75 tons per month; as one-third of this was being recovered from old waste dumps, the prospect of an increase in output is remote.

The deposits at Lung-shan are principally owned and worked by the Pao-li Smelting Co. of Changsha. These were not visited, but the owners state that the ore carrier is limestone as at the Hsin-hua mines and that the output exceeds 100 tons of picked ore and concentrates per month. . . .

### Liquation Performed in Double-Pot Furnaces

A few thousand tons of high-grade ore and a small quantity of "ash," or liquation residues, are exported annually, but the bulk of the production is marketed in the form of "crude" and "regulus." These two terms are metallurgical misnomers, sanctified by long usage; the name "antimony crude" being applied to the product obtained from liquation of the sulphide, stibnite, and "antimony regulus" meaning the metal, sometimes inaccurately styled "refined antimony."

The type of furnace employed by the Chinese for the production of crude is the same throughout the province. It consists of a narrow furnace built of ordinary brick and containing two pairs of pots, or crucibles. The upper one of each set, into which the ore is charged, is fitted into the lower as shown in the accompanying illustration; the molten sulphide trickles through a ½-in. hole in the bottom edge of the upper pot into the lower one, which is bedded in the sand or ashes in order to avoid the full temperature of the furnace. A flue along the top of the furnace connects with the main flue, or chimney, about which the furnaces are invariably built in pairs, though it will be observed that each pair of crucibles is fired independently, being separated from its neighbor by a partition wall.




LIQUATION FURNACE USED IN HUNAN PROVINCE, CHINA, FOR PRODUCING "ANTIMONY CRUDE"

A moderate draft insures the red heat necessary to effect fusion, and when sufficient of the liquated sulphide has accumulated in the lower vessel, it is ladled out into molds and solidifies into ingots of about 16 lb. each. These, when fractured, show a well-marked and characteristic acicular crystallization at right angles to the cooling surface. The ingots are packed for shipment in wooden boxes containing 224 lb. net, and of 240-lb. gross weight.

The furnace is simple in design and cheap to build and does not require much skill or experience to operate; one man usually attends four furnaces per 8-hr. shift, for which he is paid about $2.40 per month in addition to his food. The disadvantages of intermittent working and inefficiency do not appear to outweigh the good points in Chinese eyes; no effort is made to check the continuous escape of fume that is so evident. The pots used are generally of local manufacture, and have a life of 10 to

15 days; they contain a charge of 60 to 80 lb. of ore, which takes from two to four hours to run down; it is not found that fines and dust in the charge cause any trouble.

The local method of estimating the content of an ore is by the number of units (tenths) of crude produced per picul (131.6 lb.). Thus a parcel of ore is tested by putting a sample weighing one picul through the furnace, just described and weighing the resultant crude. No allowance is made for residue or volatilization losses, the ash and flue dust being the perquisite of the smelter; hence it can be readily understood that there is ample scope for dishonest practice.

### Extraction by Liquation, 64 to 83%

It is found that a high-grade ore, assaying 60% Sb, yields about 70% crude by this process, corresponding to an actual extraction of 83%; while an ore containing 45% Sb yields only 40% crude, equivalent to a 64% extraction. The difference is mainly accounted for in the ash, or residue, which rarely contains less than 12½%, and may exceed 30% Sb; this is used in the manufacture of regulus. The balance is made up by volatilization and may be reckoned at 3% to 5% of the original $Sb_2S_3$ content; this is partly recovered in the form of flue dust.

Crude varies from 68% to 73% Sb and is sold as 70% standard, which corresponds to 98% $Sb_2S_3$. The formula, $Sb_2S_3$, calls for 71.42% Sb, and it has been shown that where the metal content in the crude exceeds the theoretical amount, the excess is due to the presence of antimonious oxide, $Sb_2O_3$, and a small amount of metallic antimony.[1]

Regulus is produced principally from the lower-grade ores, containing about 30% Sb, and from liquation residues, and to a less extent from the oxidized ore, cervantite, which contains 79% Sb when pure.

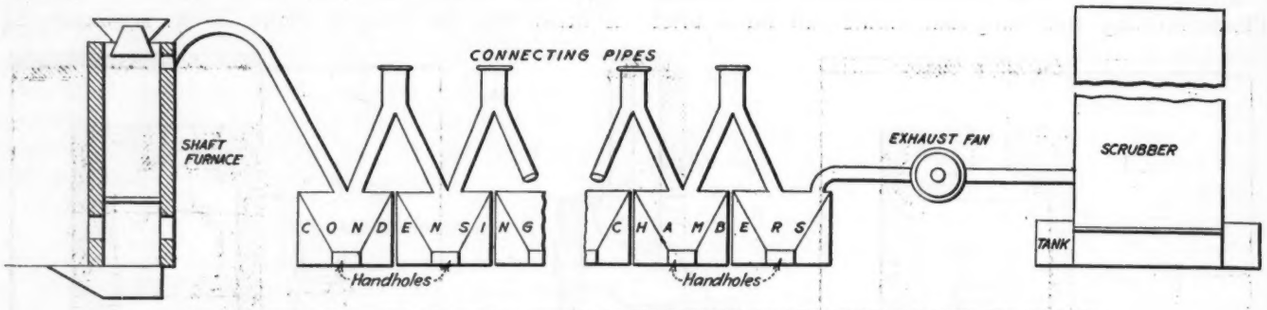
The Wah Chang company, which holds the monopoly for the production of regulus within a radius of 36 mi. of Changsha city, also owns the patent rights for China of the Herrenschmidt furnace. This consists of a shaft furnace, into which the ash or ore, previously broken small by hand and mixed with 10% of coal, coke, or charcoal, is charged; leading from the furnace is a line of condensing chambers connected with each other by cast-iron pipes of ample diameter (12 in. or more) passing from the top of one chamber with an inverted V-bend into the top of the next chamber and finally communicating with an exhaust fan, which blows into a scrubber, or coke tower, sprayed with water.

[1] "Journ. Soc. Chem. Ind.," W. R. Schoeller, Vol. 33, No. 4.

The essential feature of the process lies in the regulation of the admission of air, whereby the ore is subjected to a volatilizing roast, producing $Sb_2O_3$, which is immediately drawn off and condenses in the form of a pink-colored powder. It is removed from the chambers through handholes and is then smelted in reverberatory furnaces with coal, charcoal or coke, and soda ash, the last serving as a protective covering and reducing any $Sb_2S_3$ present. There is, however, a considerable loss by volatilization of the $Sb_2O_3$, which is partly recovered as flue dust; the total loss may exceed 30% of the original Sb content of the ore or ash.

The oxide ores, which range in metal content from 40% to 80%, are smelted direct in reverberatory furnaces. The Mei-hsiang company at Hsin-hua stated that it was smelting a 45% oxide ore, using as flux 14 lb. of powdered coal and 5 lb. of soda ash per 100 lb. of ore, two charges of 500 to 600 lb. being run per 24 hr; the smelting loss is about 21%.

Some regulus furnaces have recently been built in Hankow in which air blast is supplied at the grate and the condensing chambers are water-cooled, but otherwise following, more or less, the lines of the Herrenschmidt. Their operation is understood to have proved rather unsatisfactory, and their output is considerably less than that of Wah Chang, which has a total furnace capacity of about 600 tons of regulus per month. [According to the most recent information, the works of the Wah Chang Mining and Smelting Co., Ltd., are now capable of turning out 800 tons of regulus per month.—Editor.]




HERRENSCHMIDT EQUIPMENT FOR VOLATILIZING ROAST—NOT DRAWN TO SCALE

### Purity of Chinese Antimony

Analyses of the various brands of antimony[2] on the market show that the Chinese product is equal in purity to either Cookson's or Hallett's, though previous to the war the latter were selling at £6 to £7 per ton more than Chinese. Analyses show Wah Chang regulus to contain from 98% upward of metal, with 0.15% arsenic and traces of lead, copper and zinc. Generally speaking, the purity of both the crude and the regulus is due to the remarkable freedom of the ores from associated deleterious minerals, such as mispickel, galena, copper pyrites and blende.

The "antimony star," or fernlike crystallization on the surface of the ingot, by which the purity of the metal is often gaged, should be clear and sharp-edged, with a well-defined pattern of raised radiating markings. The fracture should show a coarsely foliated structure of large crystals of a lighter color than coarsely crystalline galena. Small specks indicate the presence of sulphur,

[2] "Min. Mag.," Vol. 7, p. 43.

and are often noticeable in regulus produced from oxide ores, owing to presence of stibnite. A granular crystalline appearance, like massive stibnite, indicates too rapid cooling.

### Only Chinese Export Statistics Reliable

The trade returns of the Chinese Maritime Customs furnish reliable figures of exports and imports passing the various customs stations and treaty ports in China, but apart from these the official statistics cannot be trusted. Chinese mines and works rarely keep any accurate or reliable records of costs or outputs, and the figures given are often palpably erroneous. Since the home consumption is low (a small amount being used for pewterware and other alloys), the table of exports, compiled from the Chinese Maritime Customs returns, probably represents 90% of the total antimony production of the country.

The small amount of regulus that comes from the provinces of Yunnan, Kwangsi and Kwangtung is all marketed in Hongkong. This is mainly produced by the Pao Hua company, at Chih Ts'un, near Mengtze, in Yunnan, where four Herrenschmidt furnaces are now in commission, putting out about 60 tons per month.

ANTIMONY EXPORTS FROM CHINA—LONG TONS

| | 1910 | 1911 | 1912 | 1913 | 1914* |
|---|---|---|---|---|---|
| Regulus | 6,472 | 6,816 | 13,197 | 12,710 | 3,000 |
| Crude | | | | | 16,137 |
| Ore | 5,620 | 6,646 | 2,005 | 4,243 | |
| Ash or residue | .... | .... | .... | .... | 4,837 |

*Exports from Changsha, Hunan Province, in 1914, were: Regulus, 2,703 tons; crude, 14,564; ore, 9,233; ash or residue, 2,523.

[In 1910 and 1911, several attempts were made by a British company to secure control of the entire Chinese crude output, but it was found impracticable because of the ignorance, jealousies and great mistrust existing among the multitude of small producers.—Editor.]

The world's annual production of antimony has risen from less than 18,000 tons in 1910 to probably over 40,000 tons at present.

## Fatality Rate in Placer Mines

There were 15 fatalities at placer mines of the United States and Alaska in 1914. At 743 operations, embracing dredging, hydraulic and drift mines, 6,521 men were employed and the fatality rate per thousand men employed was consequently 2.30, according to statistics collected by Albert H. Fay.[1]

Five of these men were killed in dredging operations, two in hydraulicking and eight in underground or drift mines. The fatality rate in placer mines is lower than that of other metal mines, but is about the same as the rate for "openpit mining, without steam shovels." The Alaskan placer mines worked on the average 180 days, while the average length of the season for placer mines in the States was 231 days.

**The Mineral Production of Nova Scotia** during the year ended Sept. 30, 1915, has been officially reported by the Commissioner of Public Works and Mines as follows, the less important items being omitted: Coal, 6,379,463 long tons; pig iron, 295,868 short tons; steel ingots, 369,310; coke, 452,099; gypsum, 230,216; gold-bearing ore, 25,204 short tons; gold, 7,216 oz.; barytes, 750 long tons; antimony ore, 10,872 long tons. Imports of iron ore amounted to 665,541 long tons.

[1]Technical Paper 129, U. S. Bureau of Mines, Washington, D. C.

## Minerals Separation, Ltd.

The tenth annual meeting of Minerals Separation, Ltd., was held on Dec. 29, 1915, at London. John Ballot, chairman and managing director, presided and in the course of his address to the stockholders brought out some interesting points, among which are the following:

With regard to the American Syndicate, the sum of £100,000 was subscribed for working capital, of which £87,500 has been called and paid, and on June 30, 1915, the income, or revenue, received by the Syndicate amounted to £34,509, making a total of £122,009 cash received, of which £114,744 has been spent on capital account and litigation, so that on June 30 the parent company and the American subsidiary have together expended no less than £340,598 in developing, maintaining and perfecting the patents and processes, and on the lengthy and costly litigation forced on them to defend their patent rights.

We have a list of well over a hundred mining companies, private mines and mine owners, engineers and others, who have installed, or are installing, flotation on their own or in other people's mills, without license from us or without even so much as asking permission or terms to use our property. If and when the Supreme Court of the United States decides the case in our favor—which I sincerely hope and believe it will do—we shall make it our business not only to look up all these users, but to keep in close touch with them on as equitable lines as possible. Among others we may, I hope, have to direct special attention to the Butte & Superior company, which you will remember as the principal and backer of the infringer Hyde and which was ordered by the court in 1913 to file a sworn statement every month setting forth the quantity of ore treated by it, with results obtained and profits made by flotation. According to these attested returns, which have been filed ever since November of that year, I find that it treated 688,491 short tons of ore between November, 1913, and September, 1915, for a recovery of 153,109 tons of concentrates, containing by assay an average of 53.3% zinc, 25.3 oz. silver, 0.56% copper, and 0.046 oz. gold per ton of concentrate. The profit it claims to have made from flotation products alone averaged $9.60 per ton of ore treated, or a total of $6,627,398.

### Large Tonnage Treated Under License

As to other general results, it will interest you to know that during the present year (1915) I estimate that the licensees of our affiliated companies and of ourselves will in all treat over 4,500,000 tons of ore by flotation, and during the coming year these same licensees with plants erected or in course of erection and expected to commence operations early in the new year will treat over 13,000,000 tons of ore by our process. In these estimates I do not include the considerable tonnages treated, or that will be treated, by the hundred or more that are not licensed. The greater proportion of this estimated large increase of tonnage for 1916 will consist of copper ores and tailings, although zinc and lead ores and dumps and low-grade ores will show considerable increases, in so far as America is concerned, over previous years.

Among the new licensees in America, the great Anaconda Copper Mining Co. enters the list with a record

installation to treat 15,000 tons of crude ore and 1,000 tons of dump slime per day. It has also just decided to erect an all-flotation mill at Anaconda to treat 1,200 tons of zinc ore per day. This plant will be completed by September, 1916, and will be the first all-flotation zinc concentrator in America. Of the older licensees, the Inspiration company is at present treating 7,000 tons per day, but I understand that it hopes to have its 15,000-ton all-flotation mill completed and operating in 1916. The Britannia, in Vancouver, B. C., has completed the first 1,000-ton section of its new 4,000-ton plant, while the Braden Co., in Chile, expects to complete the extension of its plant from 3,000 to 4,500 tons per day before the end of this year. Later, it is hoped to increase it to 10,000 tons per day. The Portland Gold Mining Co., of Cripple Creek, Colo., has carried on a series of flotation tests on its low-grade ores, with the result that it has taken a license from us and is erecting a 2,000-ton per day flotation mill to treat its own and the other large Cripple Creek dumps, estimated at 11,000,000 tons.

### The Contract with the Copper Companies

Doctor Gregory, resident managing director in America, of the American Syndicate, negotiated and completed in New York on Feb. 1 of this year, with a group consisting of the Anaconda and Inspiration copper companies, by which the Anaconda Copper Mining Co. took formal license from Minerals Separation, acting on behalf of the American Syndicate, and agreed to pay royalties on the same scale as that of the license taken by the Inspiration Copper Co. in April, 1913.

Both companies also specially agreed to pay on all ores, tailings, etc., that they may treat by flotation, irrespective of the class or type of machine used, or whether such belonged to us or to anyone else. They were given further special wholesale rates in consideration of their guaranteeing to pay a minimum sum of $300,000 by way of royalties between Feb. 1, 1915, and within five days after the Supreme Court in Washington had finally decided in the case against J. M. Hyde, and they undertook to pay that sum, no matter how soon the judgment was given or whether we win or lose. These wholesale rates, however, only came into operation after they were actually treating each quarter a daily average of over 10,000 tons, or over 790,000 tons per quarter. Meanwhile, until the Supreme Court case had been decided, they were to pay according to scale, on all ores treated by their group, whether the sum of $300,000 be exceeded or not. In consideration of the foregoing, and because of taking a license from us before the Supreme Court had decided the issue in question, they will have the right for a period of 60 days after that court has determined or dismissed the suit or appeal to elect whether they would continue the said license and agreement with us or terminate it; and if they decided to continue, they jointly and severally undertook and guaranteed that the royalties at the agreed rate shall be placed to our American company upon at least 25,000,000 tons of ore, beginning from February, 1915, the whole to be paid on or before Nov. 6, 1923. If they elected to terminate both license and agreement, both parties will practically remain as they were before, except that on our part it is understood and agreed not to sue them for infringement on apparatus claims in respect to any apparatus installed by them while they were working under license.

The guarantee of 25,000,000 tons is a minimum. The companies will not treat less than that, but they will continue to pay on anything they treat beyond that. It was also agreed with the Anaconda group to extend the same privileges to four other great copper mines named by them, provided any of them applied and took licenses from us through the Anaconda group, in which case the royalties should also be collected and paid by the latter group. One of these mines, the Arizona Copper Co., Ltd., has since taken a license and commenced paying royalties last June. It may be of interest here to mention that the spirit and intention of the agreement entered into was so energetically carried out by our friends that, during the September quarter of this year, the Anaconda and Inspiration had jointly treated and paid on 496,912 tons of ore, while I estimate that for the quarter ending this week they will have treated over 1,000,000 more tons.

## Reserve Corps of Engineers

A bill has been introduced in Congress, at the instance of the War Department, providing for organization of a Reserve Corps of Engineers, to reinforce the Engineer Corps of the regular Army in the event of war, as a result of the work of the joint committee of the national engineering societies.

**This legislation, with amendments proposed by the General Staff, provides for the giving of commissions to men who, by examination or otherwise as determined by the President, have demonstrated their fitness. These commissions, which are to be for all grades up to and including the rank of major, are for five years, renewable at the discretion of the Secretary of War, which permits the elimination of deadwood without friction. If a commission is not renewed the holder will be honorably discharged from the service and will be entitled to wear his uniform on occasions of ceremony and use the title of his rank. In times of war these officers will be subject to call precisely the same as any other officer of the army, and in times of peace for two weeks' service each year, or longer with the officer's consent.**

## Important Work at Leadville

The inauguration of a general pumping scheme for the unwatering of the lower levels of the mines of Leadville promises much for that district. The Down Town mines are now practically unwatered, through the Penrose shaft.

The United States Smelting, Refining and Mining Co. has acquired the rights to about all of the important mines of the Fryer Hill district under a 20-year lease and is about to begin pumping for the unwatering of that district, if it has not already done so. The United States company expects to find deposits of zinc ore—both calamine and sulphide—in this district. The Iron Silver Mining Co. recently purchased the New Marion group of mines, giving that company a continuous stretch of ground from Iowa Gulch to Stray Horse Gulch. This company proposes to unwater the Graham Park region through the Mikado shaft. It also is looking for zinc ore.

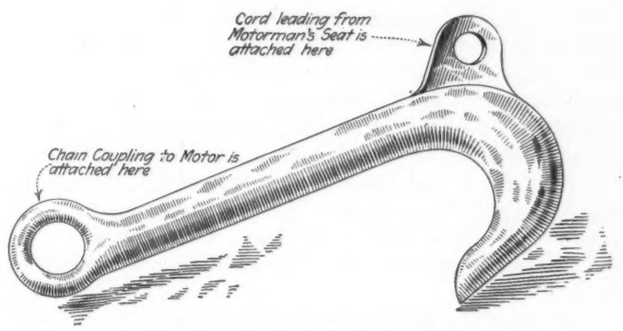
**Coöperation of Diamond Producers** was again the subject of discussion in South Africa, when Sir Thomas Cullinan presided at the annual meeting of the Premier Diamond Mining Co. on Feb. 26. Owing to the restricted demand for diamonds which is expected to follow the war, the diamond-producing companies have already curtailed their output and there is talk of a consolidation or convention to regulate outputs and avoid over-production. The Premier company is not operating its mine, present work being restricted to dump material.

# Details of Practical Mining

## Coupling Hook for Mine Motors

The novel and useful coupling hook illustrated herewith was invented by John R. Jones, motorman on the 2,000-ft. level of the Leonard mine, at Butte. It is used in disconnecting a train of mine cars from the electric haulage motor when the train is connected to the end of the motor opposite to that at which the motorman's seat is situated.

The operation is very simple and is accomplished by the motorman pulling a cord that is attached to the hook at




COUPLING HOOK FOR MINE-HAULAGE MOTORS

the offset eye. This causes the hook to turn in the connecting-chain link and to be disengaged from it.

In some cases it is necessary to have a man on the train to do this work, and the uncoupling is often done while the train is in motion. Needless to say, this is a dangerous practice and one that the men are not supposed to indulge in. The use of this hook makes it unnecessary for a man to get his hands and arms between the motor and the cars to uncouple them, and in some places it will save the labor of one man on the train.

The motors on the 2,000- and 1,800-ft. levels of the Leonard mine have been equipped with these hooks, and they have proved satisfactory.—*The Anode.*

## Working Life of Valve Facings*

Experiments at the Old Dominion mine, Globe, Ariz., have been made with numerous kinds of valve facings—brass, steel, fiber and leather. A record of valve service experience had previous to the 1915 flood with valves on the triple-expansion flywheel pumps showed that with clear-water conditions, the brass valves averaged 37 days in service, the steel valves 70, the fiber 105 and the leather 64. One clear-water pump has run as long as 180 days without a valve change.

The costs for the various valves are: Brass, $15.37; steel, $3.99; fiber $17.82; leather, $3.86. The fiber and leather valves have to be discarded when once worn out, while the brass and steel valves can be refaced at a cost of 55c. and 65c. respectively. The foregoing figures from normal conditions with these pumps favor the use of the steel-faced valve, but used with gritty and sandy water, the steel valve gave very short service, and leather, fiber and rubber were all tried in turn. The fiber and hard-leather valves were found preferable; the better grades of fiber lasting from 4 to 6 days, and hard leather about the same length of time.

The data given relate to clear-water conditions as contrasted with the gritty water pumped during the flood of 1915. When the Prescott triple-expansion pumps were running at from 33 to 37 r.p.m. pumping sandy water, new valves were required about every 48 hr. in both suction and discharge chambers, and the hard-rubber valve seemed to give better service than any other kind. At the normal speed and pumping clear water, rubber valves also gave best service in the triple-expansion Prescott pumps and were often in good condition at the end of two months.

*Excerpt from paper entitled, "The Water Problem at the Old Dominion Mine," by P. G. Beckett, Globe, Ariz., to be presented at Arizona meeting of A. I. M. E., September, 1916.

## Machine-Drilling at Treadwell Mines, Alaska

By E. P. Kennedy*

For years the standard machine drill in use in the Treadwell mines (the Treadwell, Mexican, 700 and the Ready Bullion mines, all of which are connected by underground workings and are under the one management) was the Ingersoll-Sergeant piston machine. Two sizes were in use—the 3¼- and the 3⅝-in. machines. Shaft sinking was done exclusively with the larger machines, which were also used in the openpits.

In the openpits, holes were drilled 12 ft. deep, approximately vertical, with a set of steel consisting of six drills. No openpit work was done after the year 1907. Holes underground were drilled approximately 7 ft. deep and a standard set of steel prior to 1908 for underground use in the Treadwell mines is described in the following tabulation:

| | Shank End | | Bit End | | Drill | | |
|---|---|---|---|---|---|---|---|
| | Length, | Size Oct., | Length, | Size Cru., | Length, | | Gage |
| No. | In. | In. | In. | In. | Ft. | In. | In. |
| 1 | 18 | 1¼ | 18 | 1¾ | 3 | .. | 2¾ |
| 2 | 44 | 1¼ | 14 | 1¾ | 4 | 10 | 2½ |
| 3 | 66 | 1¼ | 14 | 1¾ | 6 | 8 | 2¼ |
| 4 | 88 | 1⅛ | 14 | 1½ | 8 | 6 | 2 |

The set of steel weighs approximately 110 lb. and was made up by contract at a cost of 35c. a drill for labor only, to which should be added the cost of coal or oil, borax and steel wasted in welding. The chucks of the machines to receive the drills were fitted with octagon bushings to receive the 1¼-in. octagon drill shank, and the 1⅛-in. shank of the No. 4 drill was upset to 1¼-in. size.

*Mining engineer, 720 Foxcroft Building, San Francisco, Calif.

In January, 1908, I had a machine fitted up with a cruciform bushing to receive 1½-in. cruciform steel and had sets of steel made up as follows:

| No. | Length, Ft. | Length, In. | Dia. Cru., In. | Gage, In. |
|---|---|---|---|---|
| 1 | 3 | .. | 1½ | 2¼ |
| 2 | 4 | 10 | 1½ | 2 |
| 3 | 6 | 8 | 1⅜ | 1¾ |
| 4 | 8 | 6 | 1¼ | 1½ |

An extended trial with this machine proved conclusively the advantage of changing, and as rapidly as it could be economically done, all piston machines were fitted with cruciform bushings and the old steel gradually replaced by the new drills. The change of gage reduced the amount of material to be cut in drilling a hole by 37%, and the change to all cruciform steel obviated welding and also reduced the weight of steel per set 14%.

The main difficulty to be overcome before making the change was to obtain satisfactory cruciform chuck bushings at a reasonable cost. This was accomplished by purchasing cast-steel bushings which only required to be finished on the outside after receiving at the mine. These bushings cost 35c. each in the East and proved in every way satisfactory.

### Tryout of Hammer-Stoping Machines

Early in 1908 the writer made a thorough tryout of the hammer-stoping machines then on the market. A stope was turned over exclusively to these machines in charge on each shift of a reliable, unbiased, first-class miner, exceptionally well qualified, as known through long personal acquaintance, to give a thorough and fair trial. A three months' trial proved conclusively that this type of machine was not adapted for stoping as carried on at Treadwell. These machines are best adapted for more or less vertical holes, and a number of them are always in use in the mines for drilling survey and light plugs and in driving raises where the ground is not too hard. Slate raises are always driven with hammer drills, but when a very hard rib of ground is encountered, the contractors set up a bar and haul up a 3¼-in. piston machine—a hard task when the raise is of any height, though a profitable one as they have found by experience.

Water-Leyner machines were then tried, and they survived the prejudice against introducing anything new and proved their economy over the piston machines.

### Effect of Introducing Water-Leyner Drills

These water-Leyners were strictly one-man machines weighing about 110 lb., and they averaged as much footage per shift in the stopes as the two-man piston drill. The increased cost for hollow steel, drill-sharpening, oil, general repairs and upkeep was far more than offset by the saving in labor. The rate of air consumption for the water-Leyner was about 80% of the 3¼-in. piston machine, but as the Leyner ran steadier, the daily air consumption might not be much different. By 1913 all stoping piston machines in the Mexican, 700 and Ready Bullion mines had been gradually replaced by water-Leyners, and progress was being made toward replacing the piston machines in the Treadwell mine.

A Treadwell mine crew drove the main crosscut 12 ft. wide, from the central shaft on the 2,100-ft. level by using a crossbar on which was mounted four water-Leyner machines, making a progress in the month of April, 1914, of 372 ft., which was far more than was ever made in any of the mines previously in the same length of time. The crosscut was started with two piston machines run by a machine man and helper. Overnight this equipment was replaced by four Leyner machines, and the machine helpers became, like their partners, machine men. These water-Leyner machines finally overcame the misgivings of the dyed-in-the-wool piston-machine men and made a good start toward replacing piston machines in the Treadwell mine.

Shaft sinking had been done with 3⅝-in. piston machines for so long that when it was decided to sink the Ready Bullion shaft with hammer drills, the contractors would not bid on the shaft. It was therefore sunk on a day's-pay basis at a saving to the company, and proved a demonstration to the contractors, who were willing to take the shaft on contract before sinking had finished. Since the sinking of this shaft, the self-rotating jackhamer machines have been introduced and proved a great improvement.

### Old Practice of Drilling Long Rounds Deprecated

The popular slogan adopted generally by uptodate enterprises of the day—"Safety First"—calls loudly for the change of the old practice of drilling long rounds in the bottom of a shaft. Such necessitate the use of large quantities of powder, produce a great pile of muck, expose the crew to the danger of exploding powder in cleaning it out and later to the danger of drilling into missed holes. The change to the jackhamer machine will answer this call, and the same slogan will hurry along the replacement of piston machines in drifting by the water-Leyner type.

Following is a tabulation of the average footage drilled per machine-shift for a period of seven years by machines engaged in stoping:

| Year | Ready Bullion Mine | Mexican Mine | Treadwell Mine |
|---|---|---|---|
| 1907 | 33.3 ft. | 31.1 ft. | ..... |
| 1908 | 31.7 ft. | 25.9 ft. | 33.0 ft. |
| 1909 | 33.1 ft. | 27.2 ft. | 26.1 ft. |
| 1910 | 29.4 ft. | 33.5 ft. | 26.6 ft. |
| 1911 | 32.7 ft. | 28.6 ft. | 27.9 ft. |
| 1912 | 34.5 ft. | 21.0 ft. | 26.4 ft. |
| 1913 | 34.0 ft. | 29.4 ft. | 28.3 ft. |

The Treadwell fiscal year prior to 1911 ended in May. Tabulation for 1911 under Treadwell mine includes 18 months, making the Treadwell mine year conform to the Ready Bullion, Mexican and calendar year thereafter.

The figures under Treadwell mine represent the drilling of 3¼-in. piston machines, the figures for the first four years under Ready Bullion Mine and Mexican Mine represent the drilling of 3¼-in. piston machines, the next two years include piston and water-Leyner machines, while the figures for the year 1913 represent the drilling of water-Leyner machines exclusively.

Although the benefit derived from the change of gage for the piston machines is not reflected in the figures given, it was owing to this change that a falling off did not follow in the drilling as a result of the disturbed condition following labor strikes in 1907 and 1908. The real aim in stoping is not drilling, but tons broken per machine shift. However as the water-Leyner machine in the stope is capable of drilling any hole with equal facility that the piston machine can, and it can moreover drill flat holes which cannot be drilled practically with the piston machine, it follows that the tonnage broken per Leyner machine shift can at least be made equal to the tonnage broken per piston machine shift, and probably will average to exceed it.

## Small Timber Headframes

Small timber headframes for mines during the development period are much more likely to be guessed at or copied than to be designed, and the accompanying sketches are offered not as models, but as examples of various sizes of headframes that have stood the test of actual practice. All are Goldfield frames and may be copied with the assurance that they have been tested by the other fellow and found to be reasonably satisfactory. The table shows the material required for each. The designations 23-, 33-, 43- and 60-ft. headframes are taken from the working drawings. To be technically correct the height that designates the frame should be measured from the mudsill to the center of the hoisting sheave. It is perhaps an open question whether it is better to specify a headframe by the over-all height or the height to the center of the sheave. Both ways are used.

There is little use discussing the types of design of the frames submitted, the method of bracing, etc. The conditions under which they are erected and the premises postulated make the personal equation and the cost overbalance any argument of structural details or a stress diagram. But all of these headframes have been used with satisfaction. The 60-ft. frame mentioned in the table was described and illustrated in the *Engineering and Mining Journal* of Aug. 19, 1911.

MATERIALS FOR HEADFRAMES

| | 60 ft. | 40 ft. | 33 ft. | 23 ft. |
|---|---|---|---|---|
| Feet of timber..... | 23,000 | 7,400 | 3,900 | 1,200 |
| Rods and bolts and nuts.... | 3,300 lb. | 660 lb. | 260 lb. | 140 lb. |
| Cast-iron washers ..... | 500 lb. | 75 lb. | 55 lb. | 25 lb. |

Fig. 1 shows a small headframe used at the Krise shaft on the Goldfield Daisy. Fig. 2 is a higher, heavier, more substantial one used at the Peer & Pugh shaft, also on the Daisy property. Fig. 3 shows one of the most substantial small frames used in Goldfield. It was at the Truett shaft and, as shown, was arranged for two-compartment hoists. It is an unusually good type of headframe for a leasing proposition.

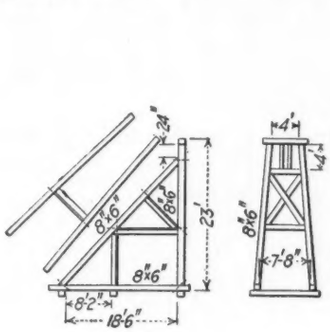



FIG. 1

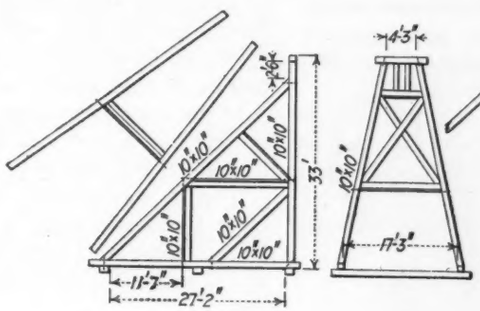



FIG. 2

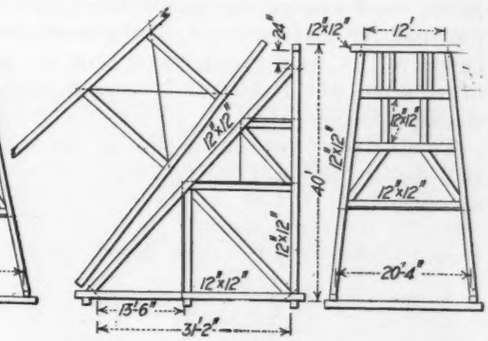



FIG. 3

FIGS. 1 TO 3. TYPICAL GOLDFIELD HEADFRAMES FOR DEVELOPMENT WORK

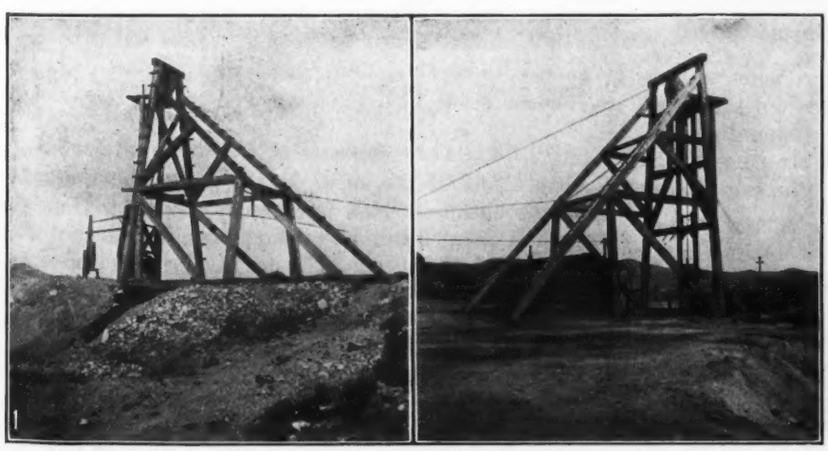


FIG. 4. TIMBER HEADFRAMES ON GOLDFIELD DAISY
1—At single-compartment shaft of Peer & Pugh lease. 2—At double-compartment shaft of Truett lease

## Vitiation of Mine Air by Use of Gasoline Locomotives*

The noxious gases from a gasoline engine used in a mine must be so diluted by the air current as to make them harmless. Air with 0.05% carbon monoxide is sufficient to produce in time very slight symptoms of poisoning in man; 0.10% may cause a headache in 40 or 50 min. These facts seem to indicate that the allowable percentage of carbon monoxide should never exceed 0.1% for short and infrequent intervals, and that the average content should be kept below 0.05%.

To keep the carbon-monoxide content of mine air below 0.10% would require that 1,000 cu.ft. of fresh air per min. pass the locomotive for each cubic foot of carbon monoxide possible for the locomotive to generate. The greatest proportion of carbon monoxide observed in the exhaust gases during the tests was 13.5%, with the engine running at full speed and full load. The air required can be reduced in the ratio of twice the percentage of carbon monoxide actually found by test, to the maximum percentage of 13.5. Multiplying by 2 the actual percentage found by test provides a factor of safety to cover occasional lapses of operation and interruptions of ventilation. Thus a locomotive having four 7x7-in. cylinders is capable of generating with poor carburation 18 cu.ft. of carbon monoxide per min., and 18,000 cu.ft. of air per min. should pass the locomotive when so operated, to keep the proportion of that gas below 0.1%. If the quantity of carbon monoxide produced during actual operation was shown by test not to exceed 4%, it would seem safe and reasonable to assume that $\frac{8}{13.5} \times 18{,}000$, or 59% of 18,000, or 10,700 cu.ft., would be a safe quantity under the stated conditions.

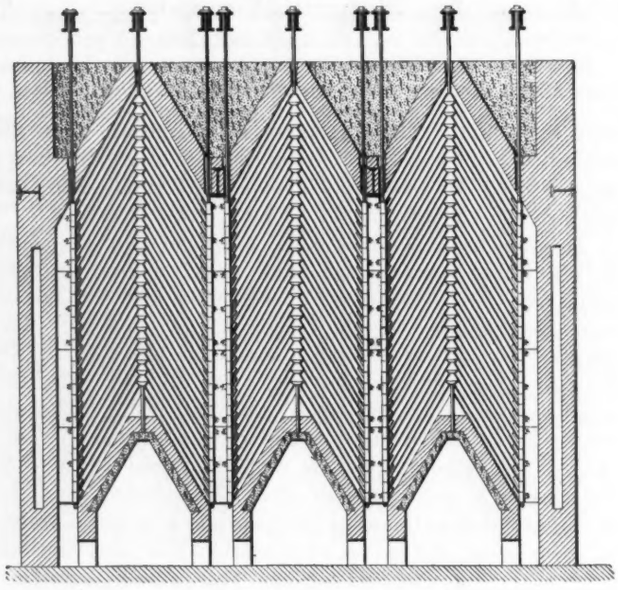
*Excerpt from Bulletin No. 74, U. S. Bureau of Mines, entitled "Gasoline Mine Locomotives in Relation to Safety and Health."

# Details of Milling and Smelting

## Wedge Dust-Collecting Chamber

Utley Wedge, of Ardmore, Penn., has patented (U. S. Pat. 1,165,351) a dust chamber having therein a series of inclined parallel plates between which the dust-laden gases are passed; the plates are periodically agitated or jarred to discharge the accumulated dust into pockets provided for that purpose. The general features of the device will be readily understood from the accompanying illustration, which shows a transverse view of the dust chamber.

To discharge the dust collected on the plate, it is sufficient to jar the supporting rod from which the plates are suspended, a blow or succession of blows delivered upon the rod above the roof being sufficient to impart a tremor to the plates and cause dislodgment of the material



WEDGE DUST CHAMBER

accumulating thereon. The dust-retaining plates are so mounted that they will not be held rigidly and thus prevented from being agitated by the blows upon the supporting rod. A variety of constructions are covered relating to the mounting of the plates and the removal of the deposited material.

**Furnace Insulation** can be best accomplished by introducing in the walls materials having different heat-transmitting qualities, thus breaking up or changing the wave length. P. A. Boeck, chemical engineer of the Kieselguhr Co. of America, in a paper before the Chicago section of the American Society of Mechanical Engineers, suggested that since heat was a form of energy consisting of molecular vibration of a periodic character, the introduction in a furnace wall of bricks of different density would help to break up or change the wave length; layers of insulating powder may also be used, or air spaces; but care should be exercised in this application of the last named, as large voids have the effect of propagating heat by convection and radiation.

## Metallurgy of the Ores from Cobalt, Ont.*

The cobalt plant of the Canadian Copper Co. was situated at Copper Cliff, Ont., about one-half mile south of the large copper-nickel smeltery. The works were remodeled and designed to smelt and treat ores and concentrates from the Cobalt silver district. The plant was in operation from December, 1905, to February, 1913, during which time more than 40,000,000 oz. of silver, 2,200,000 lb. of cobalt, 1,500,000 lb. of nickel, and 4,500,000 lb. of pure arsenic were produced.

If the ore was in large lumps, it was crushed and then ground in a Krupp ball mill to pass 30-mesh. For sampling about 6% was cut by a Snyder sampler.

The ore was charged with suitable fluxes into 32x72-in. blast furnaces having a capacity of 25 to 30 tons per 24 hr. Limestone from Michigan was used as a basic flux, and low-grade Crown-Reserve ore was used as the acid flux.

The products of the blast furnaces were: (1) Flue dust and crude arsenic; (2) slag; (3) silver bullion and (4) speiss.

The crude arsenic and flue dust from the blast furnaces and roasting furnaces were collected in suitable condensing chambers. The flue dust was recharged to the blast furnaces, and the crude arsenic was sublimed from an arsenic refining furnace, which made it ready for packing. Pure white arsenic assayed 99.98% arsenic oxide with about 0.03 oz. of silver per ton.

The slag from the blast furnaces during ore runs was rejected except when it was found to carry more than 10 oz. of silver per ton, in which case it was returned to the blast furnaces. The slag produced while smelting speiss to remove the iron was all used on ore runs because of its high silver and high cobalt content. Complete assays of the two slags were as follows:

| | Ore Slag, Oz. | Speiss Slag, Oz. |
|---|---|---|
| Silver | 8.8 | 32.8 |
| Arsenic | 0.13 | 0.47 |
| Cobalt | 0.44 | 13.97 |
| Nickel | 0.29 | 1.28 |
| Iron oxide | 11.63 | 28.54 |
| Aluminum oxide | 14.15 | 9.75 |
| Calcium oxide | 22.78 | 6.50 |
| Magnesium oxide | 8.67 | 4.68 |
| Silica | 41.13 | 34.03 |
| | 99.35 | 99.22 |

About 75% of the silver in the ore charged was obtained as buttons, which were easily separated from the speiss and charged into an oil-fired cupeling furnace with a capacity of 30,000 oz. The crude silver assayed about 860 fine. After about 24 hr. in the cupeling furnace it was ladeled out 994 fine and sent to the Balbach Smelting and Refining Co. for further treatment.

The speiss was brittle as a rule and easily broken with a hammer. After being run through a crusher, it was ground in the ball mill to pass 30-mesh, 20% of salt being added as the speiss was charged to the mill. This speiss,

*Excerpts from a paper by Ralph W. Bridges, in the "Canadian Mining Journal," Jan. 15, 1916.

known as high-iron speiss, was roasted in eight Edwards reverberatory furnaces fitted with mechanical rabbles and having a capacity of 2,400 lb. per 24 hr. The composition averaged about 25.2% Co; 15.3 Ni; 31.3 As; 16.1% Fe; and 1,480 oz. Ag per ton.

The product of the roasting was a chloridized speiss, which was transferred from the smelter to the hypo-leaching building. Here it was treated in a large agitation cylinder, first with cold water, which dissolved out the undecomposed salt and the soluble salts of cobalt, nickel and copper. This water solution was decanted onto scrap iron to precipitate the copper and was then pumped to another tank, where the cobalt and nickel were precipitated as hydrates by caustic soda. This precipitate was dried, calcined to oxides, ground and barreled for shipment. The average assay of this material was: Ag, 15.0 oz.; As, 0.3%; Co, 40; Ni, 3%. Nickel is lower than the usual proportion of nickel to cobalt for the reason that it is less easily converted to a soluble salt in the chloridizing roast.

After the wash with water the treatment of speiss is continued with four covers of sodium-hyposulphite solution, which takes all the silver chloride into solution and gives the "first hypo residue," which contains 20 to 30 oz. of silver. The silver was precipitated from the hypo-solution as silver sulphide, which was collected in a filter-press, dried and mixed with sodium nitrate and carbonate. This mixture was roasted in an oil-fired furnace and then leached in hot water. The residue was a sponge-like mass of metallic silver, which was charged to the silver-refining furnace.

The "first hypo residue" resulting from the leaching process was returned to the smeltery where it was mixed with quartz and run through the blast furnaces for the purpose of removing the iron. This was made necessary because of the contract under which the "crude cobalt material" was sold, which required that the iron content be below 5%. This smelting operation resulted in a new green speiss called "low-iron speiss," carrying about Co, 28.9%; Ni 27.8; As, 29.5; Fe, 3.5%; Ag, 1,341 oz.

This speiss was milled with salt and roasted just the same as the "high-iron speiss" and then washed with water and treated with hypo. The residue in this case was called "second hypo residue." It was dried and mixed with 20% sodium nitrate and 10% sodium carbonate and roasted in a reverberatory furnace. This converted the arsenic to sodium arsenate, which was leached out with hot water. The dried residue was sold to refineries in Germany as "crude cobalt material." An average analysis was: Co, 30.7%; Ni, 28.5; As, 1.1%; Ag, 34.6 oz. per ton.

Power for operating the smeltery was supplied from the company's power plant at High Falls, Ont., 14 mi. distant from Copper Cliff; 200-300 hp. was required and 60 to 100 men were employed, working in 12-hr. shifts.

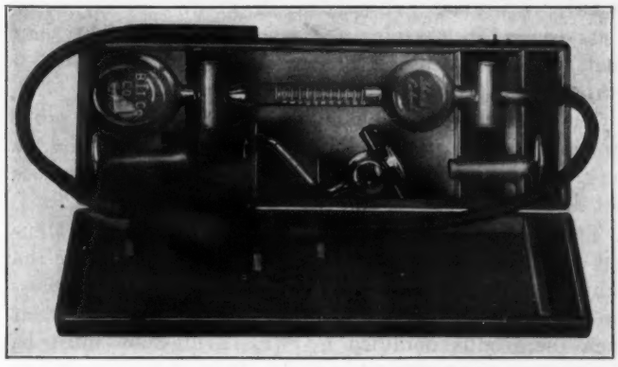
⁂

**Four Down-Draft Sintering Grates** are operated at the Braden Copper Co.'s smelting plant at Sewell, Chile, in addition to the nodulizing kilns. The sintering grates are set in long, narrow concrete boxes, 4x50 ft., connected with an exhaust fan to create a down draft. In operation, says "Teniente Topics," November, 1915, a layer of concentrates about 4 in. thick is spread upon the grate and then a 1-in. layer of sawdust. The sawdust is ignited with kerosene or gasoline torches, and with the down draft the sawdust then serves to start combustion of the concentrates, reducing the sulphur content from 28% to 12%. About 50 tons of concentrates are treated daily in the four sintering boxes.

## Pocket $CO_2$ Indicator

This little instrument is designed to determine the amount of $CO_2$ in flue and furnace gases. With it only about 2½ min. is required to make a test. It is constructed with an upper and a lower bulb; the latter is filled with potassium hydroxide (KOH), one filling being sufficient for 200 determinations.

Its operation is simple. A sample of gas is pumped in through a cock above the upper bulb. A lower cock is then turned 180° to permit the gas and KOH to come in contact. The lower cock is then closed, and the apparatus is inverted and immersed in water. The upper cock is then opened, when water will flow in to take the place of the absorbed $CO_2$. Closing what was the top cock and bringing the apparatus to its normal upright position, the percentage of $CO_2$ is read off on the tube at



A HANDY $CO_2$ INDICATOR

the water level. The water is then poured out through the top cock, and the apparatus is ready for another gas sample.

This indicator, illustrated herewith, in its case, is manufactured by the Bacharach Industrial Instrument Co., 14 Wood St., Pittsburgh, Penn. The case measures 12x4x2 in. over all, and the weight is so small that there is no inconvenience in carrying it in one's pocket. The instrument is 11¼ in. long, and the price of the outfit complete is $16.

⁂

## Amalgamating Copper Plates

By Alexander McLaren*

At amalgamation plants it frequently becomes necessary to use raw copper plates, and if a supply of cyanide is not at hand the preparation of the plate is difficult and laborious. I have devised a simple scheme that works well, and it might be of interest to the profession.

The plate is scoured with tailings and then washed clean. About 20 c.c. of nitric acid, in which is dissolved a piece of silver about the size of a dime, is boiled until the red fumes have been expelled, and then diluted with 150 c.c. of distilled water. This solution is poured over the plate, the surface of which becomes blackened. A few drops of mercury thrown on the plate and rubbed lightly will then produce a properly amalgamated surface quickly and easily. This procedure makes it possible to utilize old plates or sheets of raw copper for amalgamating in different parts of the mill, such as traps, launders, etc.

*Metallurgist, Northwestern Mining Co., Bearmouth, Mont.

# The Assayer and Chemist

## Effect of Borax in Matte Fusion

By G. E. Johnson*

The investigation was suggested by an article that appeared in the *Journal* of July 4, 1914, entitled "Effect of Acidity of Assay Slags on Silver Losses."[1] Under a discussion of the losses with copper mattes, the statement is made that using the following charge—ore, ¼ a.t.; $SiO_2$, 3 grams; PbO, 100 grams; $NaHCO_3$, 7.5 grams; $K_2CO_3$, 7.5 grams; $Na_2B_4O_7$, 10 grams; cover, borax glass—a result was obtained several ounces lower than that obtained by using a charge—ore, ¼ a.t.; $SiO_2$, 5 grams; PbO, 95 grams; $Na_2CO_3$, 30 grams.

The investigation was undertaken in order to prove two things: (1) That borax acts as an acid flux and, as such, can be used to replace $SiO_2$; (2) that borax does not dissolve or hold in solution the silver.

The first statement is verified by Fulton in his "Manual of Fire Assaying"; the second has not been made the subject for an investigation so far as known at the present time. If these two statements can be proved correct, then the results obtained by Mr. Livingstone must be due to some error of assaying other than that of improper fluxing.

### Method of Investigation

A copper matte containing 35% Cu and 17.3 oz. Ag was taken as the basis for the experiment. This matte is similar to that used by Mr. Livingstone in his experiments, with the exception of the silver, which is considerably lower. However, even with this lower content of silver it should be possible to get a curve similar to that obtained upon the higher-grade material.

Three types of charges were used: (A) Livingstone's charges for copper mattes; (B) Livingstone's charges in which borax glass replaces the $SiO_2$; (C) Livingstone's charges with enough borax added to raise the silicate-borate degree one unit. The following is a list of the charges used:

Type A

| Silicate Degree | PbO Grams | $SiO_2$ Grams | $NaHCO_3$ Grams | Ore A.t. | $K_2CO_3$ + $Na_2CO_3$ Grams | Ratio |
|---|---|---|---|---|---|---|
| ⅛ | 95 | 3 | 47.5 | ¼ | .. | 0.143 |
| ¼ | 95 | 5 | 47.5 | ¼ | .. | 0.238 |
| ½ | 90 | 10 | 47.5 | ¼ | .. | 0.435 |
| 1 (Mono.) | 60 | 10 | 23.7 | ¼ | .. | 0.822 |
| | | | Borax Glass | | | |
| Spec'l borax | 100 | 3 | 10 gm. | ¼ | 15 | 0.675 |

Type B

| | PbO | Borax Glass | $NaHCO_3$ | Ore | | Ratio |
|---|---|---|---|---|---|---|
| ⅛ | 95 | 3.5 | 47.5 | ¼ | .. | 0.125 |
| ¼ | 95 | 6.0 | 47.5 | ¼ | .. | 0.244 |
| ½ | 90 | 12.5 | 47.5 | ¼ | .. | 0.504 |
| Mono. | 60 | 16.0 | 23.7 | ¼ | .. | 0.993 |

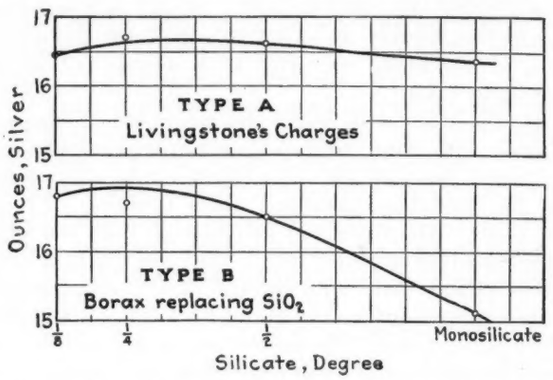
Type C

| | PbO | $SiO_2$ | $NaHCO_3$ | Ore | Borax Glass | Ratio |
|---|---|---|---|---|---|---|
| ¼ | 95 | 3 | 47.5 | ¼ | 2.7 | 0.254 |
| ½ | 95 | 5 | 47.5 | ¼ | 6.7 | 0.501 |
| Mono. | 90 | 10 | 47.5 | ¼ | 12.5 | 1.002 |
| Bi. | 60 | 10 | 23.7 | ¼ | 18.4 | 1.990 |

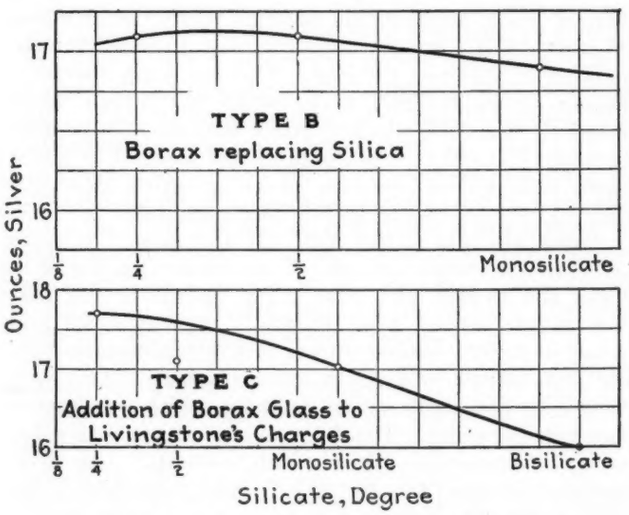
Cover: Salt. Oxidizing Agent: 6 grams $KNO_3$.

From these three types it was expected that conclusive results would be obtained. The silicate degree was calculated after assuming that a 25-gram lead button would be formed.

Attention should be called to the "Ratio" column of type A. It will be noticed that the calculated ratios do not correspond to the type of slag under "Silicate Degree." This discrepancy can be accounted for by Mr.




BORAX AND SILICA SLAGS, LOW-GRADE SILVER ORE




BORAX SLAGS, LOW-GRADE SILVER ORE

Livingstone's method of calculation. He assumed that one-half the silica combined with the $NaHCO_3$ and the remainder with the litharge; no mention is made of the weight of lead button assumed or obtained. The figures under the "Ratio" column were obtained by comparing the O in the bases to the O in the acids, taking the O in the bases as unity. By using this method of calculation, it is not necessary to assume the relative affinity of the acids and bases; neither is it possible to get more than one ratio from the same charge.

The silver values from the type A charges, when plotted on the same scale as Mr. Livingstone's, should cor-

*Rolla, Mo.

[1]D. C. Livingstone, "Eng. and Min. Journ.," Vol. 98, pp. 23-24.

respond to that obtained by him on the copper mattes. By replotting his figures, a more uniform curve may be secured; this fact was brought out by the results from type C charges. Further discussion of this point will be postponed until later.

Type B charges should prove or disprove the second of the objects of investigation. If a curve similar to type A is obtained, the statement is proved correct.

Type C was not expected to show any distinct effects, yet it seems to have become the most interesting of the three.

## Results of the Investigation

Following are the results obtained on the first set of fusions:

RESULTS OF EXPERIMENT NO. 1

| No. Fusion | Type of Slag | Silicate Degree | Wt. of Pb Button, Grams | Wt. Ag, Mg. | Oz. Ag per ton |
|---|---|---|---|---|---|
| 1 | A | ⅛ | 27 | 4.30 | 17.2 |
| 2 | A | ¼ | 28 | 4.32 | 17.3 |
| 3 | A | ½ | 28 | 4.34 | 17.4 |
| 4 | A | Mono. | 24 | 4.08 | 16.3 |
| 5 | Spec. borax | 0.675 | 27 | 4.60 | 18.4 |
| 6 | B | ⅛ | 27 | lost | ... |
| 7 | B | ¼ | 28 | 4.27 | 17.1 |
| 8 | B | ½ | 28 | 4.27 | 17.1 |
| 9 | B | Mono. | 27 | 4.20 | 16.8 |
| 10 | C | ⅛ | 28 | 4.40 | 17.7 |
| 11 | C | ½ | 29 | 4.28 | 17.1 |
| 12 | C | Mono. | 30 | 4.26 | 17.0 |
| 13 | C | Bi. | 19 | 4.01 | 16.0 |

These charges were fused in 20-gram Battersea crucibles that had been used for other ores, lower in silver; the high result on fusion No. 5, however, seems to be due to a dirty crucible. The results from experiment No. 2 seem to indicate that the assumption is true.

Inasmuch as all conditions were as nearly uniform as possible, the results should be more uniform. All the fluxes were weighed, the time of fusion was the same, and the cupellations were made in one batch. These precautions should make any variations due to changeable conditions practically negligible. A second set of fusions was run, using new crucibles, and especial care was taken that no prills of lead remained in the crucible after pouring. These results were much more uniform and are the better of the two. They are from 1 to ½ oz. lower in silver than the first lot; this, however, might easily be caused by a different temperature of fusion or slightly hotter cupellation. The results of experiment No. 2 are given in an accompanying table.

RESULTS OF EXPERIMENT NO. 2

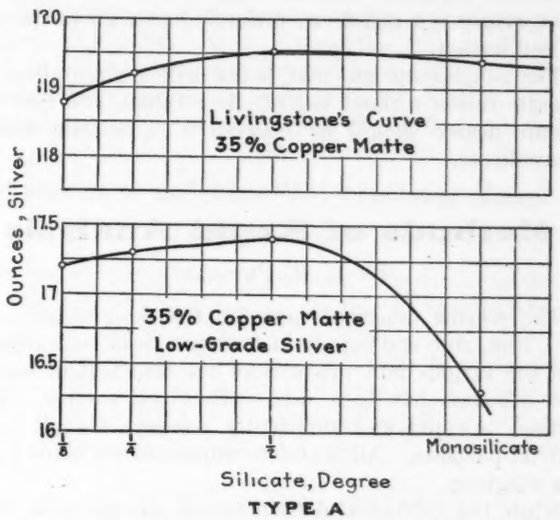
| No. of Fusion | Type of Slag | Silicate Degree | Wt. of Pb Button, Grams | Wt. Ag Mg. | Oz. Ag per Ton |
|---|---|---|---|---|---|
| 1 | A | ⅛ | 25 | 4.12 | 16.48 |
| 2 | A | ¼ | 26 | 4.18 | 16.72 |
| 3 | A | ½ | 26 | 4.14 | 16.56 |
| 4 | A | Mono. | 24 | 4.08 | 16.32 |
| 5 | Spec. Borax | 0.675 | 25 | 4.14 | 16.56 |
| 6 | B | ⅛ | 26 | 4.20 | 16.80 |
| 7 | B | ¼ | 25 | 4.18 | 16.72 |
| 8 | B | ½ | 22 | 4.12 | 16.48 |
| 9 | B | Mono. | 18 | 3.78 | 15.10 |
| 10 | C | ⅛ | 25 | 4.18 | 16.72 |
| 11 | C | ¼ | 25 | 4.16 | 16.64 |
| 12 | C | Mono. | 23 | 4.10 | 16.40 |
| 13 | C | Bi. | 12 | 2.84 | 11.50 |

Plotting curves for experiments 1 and 2 will give a better conception of the rôle played by the borax.

Type A—The curve for experiment 1 shows a striking similarity to that of Mr. Livingstone's until the monosilicate is reached. Here a sudden break occurs. This break appears to be due to experimental errors, as the curve from experiment 2 shows a curve identical with that of Mr. Livingstone's. Hence it can be assumed that the lower content of silver does not affect the direction of the curve.

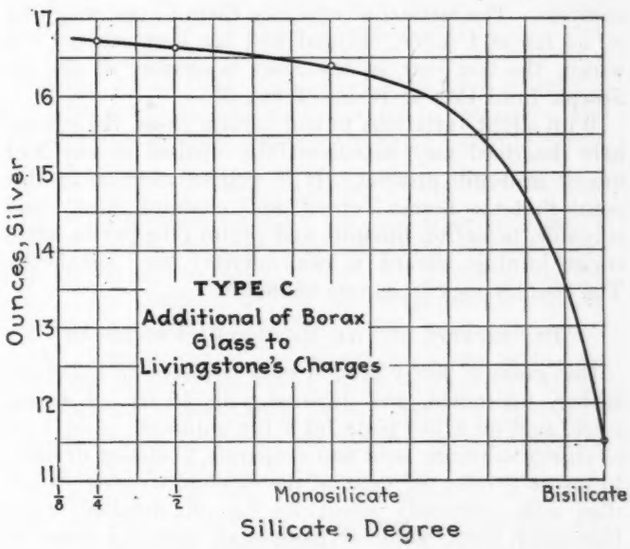
Type B—This is the charge in which borax replaces the silica. From a glance at the curves of experiment 1 and 2 a remarkably uniform set of results is shown; furthermore, the curve is the same as that of type A. Hence the second assumption, that borax does not affect a matte fusion unless the silicate degree becomes high, is proved.

The general suspicion against borax in matte fusions is no doubt due to a misunderstanding of the action




TYPE A

LIVINGSTONE'S SLAGS, 35% COPPER MATTE




LIVINGSTONE'S SLAG, WITH EXCESS ACIDITY DUE TO BORAX GLASS

(acidic) in the fusion. It is well known that silica in excess will appreciably lower the silver result. Hence neither borax nor silica should be added merely to help fuse the charge, but to make the slag a certain silicate degree; preferably between a ⅛ and ½ silicate. The results from this type are also in accord with the theory that the copper present in the charge is removed by the excess litharge.

$$Cu + PbO = CuO + Pb$$

From this it will be seen that the more acid constituents placed in the charge, the greater the PbO required

to flux this material; and this in turn leaves less excess PbO to change the copper to oxide.

Type C—Here again the curves show a uniform trend up to a monosilicate, when a sudden drop takes place. However, this drop may be due to a decrease in size of the lead button. Unfortunately the limited time did not permit of another experiment, but if a uniform size of button were obtained, the curve would no doubt straighten out. As has been said before, no especially important results were expected. The discrepancy between the curves of experiments 1 and 2 can probably be traced to the size of lead button.

The conclusions are that borax will replace silica in a matte fusion without loss of silver values, and that the silicate degree should lie between a 1/8 silicate and a monosilicate.

## Methods of Rapid Analysis

By L. B. Pringle*

The scheme described here for the determination of lead, iron, zinc and copper in lead ores, lead concentrates and the various mill products of the lead belt of southeast Missouri has been used with much success. The method is rapid and sufficiently accurate for all commercial purposes. All four determinations are made from one weighing.

While the individual determinations are not new, they are given to show any slight variations from the originals that may tend to shorten the time required for the analyses. The method of applying them to one weighing is, as far as I know, original and has been worked out within the last year in the assay laboratory of the St. Joseph Lead Co., at Bonne Terre, Mo.

With slight variations to suit certain cases, the scheme here described may be successfully applied to any lead ore or lead-mill product. It is well to mention at this point that the Bonne Terre "rock" contains chiefly lead sulphide, hematite, limonite and pyrite (the pyrite sometimes leaning toward a chalcopyrite) and sphalerite. The country-rock is impure dolomite.

### Description of the Method of Procedure

One gram of finely ground pulp is placed in a 250-c.c. beaker, moistened, and digested with 10 c.c. of strong nitric acid on a hot plate for a few minutes. Add 5 c.c of strong sulphuric acid and evaporate to almost dryness, to insure driving off most of the sulphur trioxide. Cool, then add cautiously about 50 c.c. of distilled water [hereafter when water is mentioned, distilled water is understood] and boil 5 or 10 min. Cool thoroughly in a trough, filter, and wash by decantation twice with a 2% solution of hot sulphuric acid, twice with a cold 20% solution of alcohol and once with cold water. It is well to reduce the washings as much as possible, so as not to have a large amount of filtrate. The precipitate contains the lead sulphate, and the filtrate and washings are retained for the determinations of iron, zinc and copper.

When the lead content is low (under 20%), the determination is best made by either the Guess-Haltain electrolytic method or by the chromate method. The following molybdate method, however, is the one most frequently used at Bonne Terre, particularly on mill products. To the beaker containing the lead sulphate add 15 to 20 c.c. of hot ammonium acetate and stir and keep hot until the lead sulphate is dissolved. Then instead of washing the remaining lead sulphate from the filter paper into the beaker, remove the paper, tear it into strips and put it all in the beaker. Add 50 c.c. of water, boil a few minutes, dilute to 200 c.c., boil and titrate at boiling point with a standard solution of ammonium molybdate, using a solution of tannic acid as an outside indicator.

### Estimating Iron, Copper and Zinc

To the filtrate and washings from the lead sulphate add an excess of ammonium hydroxide, boil and filter. Dissolve the precipitate with a minimum amount of hydrochloric acid, reprecipitate with ammonium hydroxide, filter through the same paper and wash thoroughly with hot water. Combine the two filtrates and washings and save for the determinations of zinc and copper.

Dissolve the precipitate in 20 c.c. of hot dilute hydrochloric acid (1 to 1), dilute to 50 c.c., heat, and add stannous-chloride solution drop by drop until the iron is reduced. Transfer to a 1,000-c.c. beaker, add 5 to 10 c.c. of saturated solution of mercuric chloride, dilute to 500 c.c., add 8 c.c. of preventive solution and titrate at once with a standard solution of potassium permanganate.

Various methods may be used for the determination of copper, but owing to the low copper content I have to contend with, the preference is given to the thiocyanate method.[1] The determination is made on half of the combined filtrates and washings from the iron.

To the filtrate and washings from the iron, or one-half of this if copper is to be determined, add just enough hydrochloric acid to neutralize the solution. Then add 3 c.c. more of the acid in excess (unless copper is present, when add 6 c.c. in excess, one gram of test lead, shake well and filter off the copper). Add 10 grams of c.p. ammonium chloride, dilute to 200 c.c., heat at 70° C. for 10 min. and titrate at once with a standard solution of potassium ferrocyanide, using ammonium hepta-molybdate as an outside indicator.

The ammonium-acetate solution used in the lead determination is made by mixing 1,000 c.c. of ammonium hydroxide with 1,250 c.c. of acetic acid (glacial). The ammonium molybdate is made up 8.7 grams per liter, and the tannic acid is of freshly prepared solution containing 0.33 gram dissolved in 100 c.c. distilled water.

In the iron determination the stannous-chloride solution consists of 1 lb. hydrochloric acid, 1 lb. stannous chloride and two liters of water. The mercuric-chloride solution is a saturated solution in hot water, cooled and filtered. What has been called the preventive solution consists of 160 grams manganous sulphate, 1,750 c.c. acid. Potassium-permanganate solution is made up of 6.32 grams c.p. crystals dissolved in water, set aside for 24 hr., filtered and diluted to 1 liter. It must be kept in a dark bottle.

The potassium-ferrocyanide solution used in the zinc determination has 21.6 grams per liter of water. The ammonium hepta-molybdate solution contains 9 grams per liter. This indicator gives a quicker end-point than the uranium salts.

*Chemist, St. Joseph Lead Co., Bonne Terre, Mo.

[1] G. A. Guess, "Journ. Amer. Chem. Soc.," Vol. 24, p. 708; the thesis of Lindeman, Columbia Univ., 1903; also pages 101-2 of Miller's "Quantitative Analysis for Mining Engineers."

## Phelps, Dodge & Co.

The annual report of Phelps, Dodge & Co. shows a total production from subsidiary companies in 1915 of 140,478,003 lb. of copper, this being an increase of 8,815,679 lb. over the output from both company and custom ores during the previous year. Including copper received from outside sources, there was sold and delivered during 1915 a total of 194,925,668 lb. of copper at an average price of 16.079c. per lb. Nearly one-half of this was sold to domestic trade and slightly over one-half to foreign trade.

These excellent results were obtained despite the curtailment in effect during the first two months of 1915, the strike at the Detroit mines in Arizona during the last quarter of the year and the Mexican troubles, which repeatedly paralyzed the railroad transportation between the Moctezuma Copper Co.'s property in Sonora and the Douglas reduction works, the Nacozari plant being idle for 135 days. No damage was done by any of the hostile forces either to the mining plant at Pilares or to the power plant or mill at Nacozari, though the town was successively occupied by opposing forces. Almost without exception supplies were paid for, and the principal drain upon the company's equipment was in horses. The policy of the company has been to employ as few Americans as possible and to educate Mexicans to take the place of Americans when the latter could be dispensed with. Consequently, when the Americans found it impractical to remain longer, the plant was placed in the hands of Señor Lugo, who displayed much ingenuity and tact in the preservation of the property.

### Novel Feature of Morenci Labor Trouble

The strike at the Detroit Copper Mining Co. in Morenci, while suspending production from September, 1915, to February, 1916, did not result in any great damage to the property and developed some novel features, the most striking of which was the housing of loyal workmen at company expense at a distance from the strike area.

The Copper Queen mines shipped 783,211 dry tons from Bisbee, besides precipitates and old-dump slag, bringing the total up to 830,777 tons, containing 88,551,180 lb. of copper, 943,368 oz. of silver, 18,974 oz. of gold and 9,388,418 lb. of lead. The ore reserves in the limestone division of the mines at Bisbee remained approximately the same as at the commencement of the year, and churn drilling extended the previously discovered bodies of disseminated ores, for which a large concentrator is to be erected.

At the Burro Mountain Copper Co. in New Mexico, construction work was carried on actively and the concentrator was practically completed. The property of the Savanna Copper Co., comprising about 2,234 acres adjoining that of the Burro Mountain company, was purchased and development has been undertaken.

Work by the Bunker Hill Mines Co., at Tombstone, Ariz., has not progressed sufficiently to determine the ultimate fate of this property. Some shipments were made from manganese orebodies that exist in these mines, to take advantage of the extraordinary market for manganese ore. About 2,000 tons, containing 1,171,599 lb. of manganese, was shipped. About 8,000 tons of silver-gold-copper-lead ore was also taken out, the greater part of which was sent to the experimental cyanide plant.

The copper ore extracted from all the company's mines amounted to 1,583,364 tons, of which 800,600 tons were submitted to preliminary concentration and 782,764 tons were smelted direct in the reduction works at Douglas.

The Stag Canon Fuel Co. mined 1,265,673 tons of coal, of which 528,859 tons were consumed in the manufacture of 265,752 tons of coke. The Phelps, Dodge Mercantile Co. did a gross business of $6,210,457, the net profit on which was 8.54%.

The dividends paid by the company during the year were $9,000,000, and the surplus at the end of the year stood at $8,337,863. It is noteworthy that among the assets of the company are listed five-year Anglo-French External Loan bonds, amounting to $1,940,000. Cash on hand was nearly $6,000,000 at the end of the year.

## Mystery of the Divining Rod

By S. Le Fevre*

Has the divining rod any scientific foundation in fact? Are the people who claim to be able to manipulate it so that it will give valuable information all fakers? These are questions that have called forth arguments, pro and con, for over a thousand years. The present article is not written as a claim that anything new has been discovered, but simply as a record of some interesting facts.

Agricola, in "De Re Metallica," translated by Mr. and Mrs. H. C. Hoover, gave a detailed description of the use of the divining rod in the Twelfth Century. His conclusion of the whole matter is: "Whoever wishes to find ore, let him go where geological conditions are favorable and dig for it."

But during all these years many men have claimed to be able to detect the presence of water underground, and a smaller number have claimed ability to locate minerals.

### Herr von Uslar Tries Divining Rod at Mineville

The writer, while manager for Witherbee Sherman & Co., had an opportunity to witness the operation of the divining rod in the hands of Herr von Uslar, a German expert, who claimed ability to detect water courses, minerals, coal and oil, by using rods made of various metals. Comparison of the indications given by his rod around the magnetic iron-ore deposits at Mineville, N. Y., with knowledge previously gained from underground workings and by dip-needle surveys and diamond drilling was intensely interesting.

The rod used for iron ore was a piece of steel wire, about the size of ordinary telephone wire, which was claimed to contain other metals. It was about 28 in. long, bent with a loop in the center so that when the rod was stretched out horizontally the loop would rise about 2 in. high in the center. When in use the rod was held horizontally and grasped tightly, with one hand on each side of the loop and a few inches away from it. The loop would stand upright between the hands. The operator walked forward, and when approaching the ore, the loop would turn down, turning the wire in the hands. Von Uslar seemed to find two points where an indication would be given on approaching, and two points on leaving the orebody; the distances between these points was used to estimate the depth of the orebody below the surface.

*Consulting mining engineer, Forest Glen, Ulster County, N. Y.

After getting over the orebody, the loop of the rod would revolve continuously about 80 times per minute, while walking across it, stopping when the limit of the ore was reached. While passing over the ore there was considerable force in the rod as it turned. Von Uslar would invite anyone to take hold of the wire projecting outside of his hand, and pinch it to see if it could be stopped, but no grip on the plain wire could keep it from turning. At one time one end of the rod was bent up at nearly a right angle for about a quarter of an inch, and one of the onlookers, thinking this offered a good grip, grasped this end between thumb and finger; the rod stopped, but surged so hard that it began to cut into the holder's thumb, the pain obliging him to drop it. If Von Uslar grasped the wire with one hand and another man held the other end of the wire, the rod would turn as long as Von Uslar's free hand clasped the other holder's wrist or gripped the back of his neck.

When passing over the surface where the underground conditions were perfectly well known from the workings, we could perceive that the working of the rod told the story of what was underneath quite correctly, because we had the proper code to interpret the indications. In one case a gabbro dike, cutting through the ore, had been encountered and driven through underground, and the ore had been found beyond. In passing over this part of the workings on the surface, the rod stopped for exactly the width that had been driven through the rock below.

### Divining Rod Checked Against Dip Needle

We also tried over ground surveyed by the dip needle and tested by diamond drilling—the divining rod confirmed these findings. It also went further and showed the indications of ore to go beyond the point where the dip needle had reached its limit, showing the divining rod to be the more sensitive. No drilling has been done as yet to test points where the rod alone showed indications of ore. It may be that for practical purposes the rod is too sensitive, possibly susceptible to influences emanating from ore in less than commercial quantities.

The rod seemed to work as well with the operator sitting in the tonneau of a moving automobile as when walking on the ground.

Herr von Uslar asserted that the power to use the rod was a natural gift that he could not explain—he knew of no one who had it to the same degree as himself. While he was in Vermont making some tests, he was followed by a young man who watched him intently and who soon found himself able to get the same indications. After experimenting, he made a rod of a combination of metals, which worked satisfactorily. This young man said he "always was an electrical cuss—couldn't stroke a cat without drawing sparks, couldn't walk on a carpet in his bare feet"—so had thought he might be able to "work the rod."

We later had this man at Mineville, traversing the same ground that Von Uslar had been over, and found he obtained indications at the same places. At this point the superintendent of mines announced—"I can locate a watercourse with an apple bough; let me try the rod;" and it worked as well with him. However, in the hands of neither of these men would the rod make a complete revolution; it would turn from a vertical position above the rod to a vertical position below, after which they would have to release and turn it up; while over the ore it would slowly turn down again, although grasped so tightly that blisters soon began to appear on the hands. A curious feature of the use of the rod by these two men was that in each trial it turned away from one and toward the other, perhaps showing opposite polarity in the two men.

F. S. Witherbee, president of Witherbee, Sherman & Co., through whose interest in the matter these trials were made, was also able to feel a tendency of the rod to turn when over the ore. In the hands of a dozen others that tried, the writer included, the rod was entirely inert.

The dip needle and magnetometer can measure and map the lines of force about a body of magnetic ore, and perhaps the divining rod in connection with some human bodies is susceptible to these same forces. If so, an instrument may be made in the future that will register these forces more accurately than even the most sensitive human organism. It may be also that other substances in the earth emit more delicate lines of force, similar to the magnetic lines about the iron orebodies, which it will take a more sensitive instrument to detect. The invention of such an instrument may possibly solve the mysteries of the divining rod, which have perplexed philosophers and scientists for centuries past.

## Metallic Magnesium Industry

At the meeting of the New York section of the American Electrochemical Society, Feb. 11, 1916, Dr. William M. Grosvenor gave an interesting and extremely instructive talk on the subject of metallic magnesium, one of the new industries of this country.

The chief uses of magnesium are:

Scavenging alloys, clearing up oxides of other metals and making far denser, cleaner, stronger and more homogeneous alloys. It is valuable in aluminum, nickel, copper, brass, bronze, etc., and special steels, because of its intense avidity for both oxygen and nitrogen.

Alloying itself, with aluminum or aluminum containing traces of one or more of the other metals, Cu, Ni, Zn, Pb, Bi, Sb, Fe, etc. It greatly modifies crystallography and physical properties, alloys readily with most metals and melts at a convenient heat.

Illumination, as in military uses for shrapnel trailers, star bombs, flare lights, etc., and in photography for flashlights. Its easy inflammability (about 800° C.), the high heat of combustion (134,000 cal.), the relatively low heat of vaporization (1,100° C.), the intensely white oxide produced and the high temperature of volatilization of this oxide are the essential factors.

### Magnitude of Consumption and Prices

Records of imports for the year prior to the war indicated 38,000 lb. About 100 lb. per day, therefore, seemed to be a safe production to undertake. Prices before the war had been very steady around $1.45 per lb., but it seemed reasonably certain that the cost need not exceed $1 per lb. After the war began, the prices being paid for remnants of imported lots quickly rose to $2.50.

Some of the first demands here were from wholly unexpected quarters, in surprising amounts and at amazing prices. The most urgent, almost pitiful demands, came from quarters that were not even suspected to be interested in the least. One consumer has contracted for 24,-

000 lb., another for 15,000 lb., these two alone taking for strictly domestic use more than was supposed to be the total importation.

It was found that a great deal of the material was being imported under other names and most carefully disguised—secrecy being preferred to economy. Prices as high as $10 per lb. were gladly paid at first for domestic product. For some months then the prices jumped around from $5 to $7.50, but every effort was made to reduce conditions to some sort of order by dealing direct with the consumer. This was partly the result of a deliberate policy for better and more intelligent service of the consumer's precise demands as to quality and delivery, but partly also the result of meeting quite unexpectedly the competition of our own product at prices from 25% below to 50% above the prices we had made. Some of New York's clever war brokers added 10% each through a chain of four or five middlemen. Others assumed direct quotations to have already been through this process and knocked off 20%, trusting that "real cash business" would squeeze down the middlemen they supposed to exist and still leave 5% for the real seller. Now, however, for a number of months the price has been practically fixed at $5.50 per pound of "guaranteed 99%," actually about 99.5%. Occasionally a lot that has been picked up in the antebellum market for speculation is let go at lower figures or a lot of lower-grade material comes on the market from abroad, but there is practically no volume of these sales.

In spite of the beautiful appearance of the German bars, they rarely exceeded 98% and often fell as low as 96%. The process of extrusion concealed impurities by drawing them out into minute threads. It is safe to say that the regular commercial grade of metal made here now is superior to anything ever imported.

### The Reasons for High Prices

It may seem ridiculous to ask or pay such prices. Let us consider. The alloy market constitutes the bulk of the business, and governs prices. In aluminum castings, for instance, about less than 2% of magnesium cleans up the aluminum and leaves ¾ to 1½% in the casting, about doubling its tensile strength and quadrupling its resistance to shock or jar. It reduces the cost of machining more than 50%, halving the number of resets on the cutting tool, giving clean-cut machine surfaces, and permitting a polish to be secured with the last cut instead of a separate operation. With care, 1½% of magnesium at $5.50 per lb. is all that is needed, 8¼c. per lb. of casting actually required to do the same work. The increase in strength means, in some cases, a reduction in weight of casting of 50%. The reduction in casting weight is generally not less than 25%. The weight of a pure aluminum casting may therefore be reduced if this 1½% of magnesium is used by from 25 to 50%. This is a great saving even at normal prices of aluminum since it amounts to about one-fourth of 20c., or 5c. With aluminum at 60c. it amounts to 15c. worth of aluminum saved for a stronger and more stable mechanical result. The saving in machine work alone, when the casting is to require much machine work, more than pays for the use of magnesium.

The manufacturer of magnesium has certain considerations (of necessity rather than mere excuse) for the high prices. Cost of production abroad prior to the war approximated $1 per lb. Sales in England were about $1.30 and here about $1.45 per lb. At that time $MgCl_26H_2O$ was selling for about $18 per ton. Present prices here are now about $60, nearly four times normal. Other chemicals used in the manufacture have increased to ten times their normal price.

In considering prices it is well to mention separately export prices. Before the war nearly all the magnesium for England, as well as the United States and France, came from Germany. Since the war both France and England are producing considerable quantities of excellent purity. This fact and the failure abroad to realize the strenuous conditions here account for the unwillingness of buyers abroad to pay more than $3.50 for powdered metal (all the named prices were ingot or bar).

At present there is being produced here at two points about all the present alloy market will absorb, and an increase of plant is being made of about 25% of the present capacity. One other producer makes only about his own requirements. Two others are soliciting business, but have failed to fill orders—in one case the order is now over a year old and still stands unfilled. All told, we believe the present production is at the rate of something over a million dollars a year and will be slightly in excess of the present domestic needs.

The use of the metal for scavenging purposes depends on price of metal compared with price of material to be scavenged. For use with copper, brass, bronze, etc., the magnesium can be used at far higher prices than for steel. But the big consumption of the material can only come when it directly replaces aluminum as the predominant metal in the alloy and arrives at a correspondingly low price. It makes beautiful castings, machines easily and well, is about a third lighter than aluminum and can be made about two to four times as strong. The coefficient of expansion reported is practically the same as aluminum. When properly pure (over 99.5%), it is apparently quite as resistant to corrosion as aluminum, equal if not superior in electrical conductivity (about half that of copper), and superior in heat conductivity to aluminum (also about half that of copper).

### Processes for Making Magnesium

1. Reduction of fused $MgCl_2$ with Na.
2. Electrolysis of the fused double chloride, usually $MgCl_2KCl_2$.
3. Reduction with carbon. (Patented.)
4. Electrolysis of dissolved MgO. (Applied for.)
5. Reduction of fused $MgCl_2$ with Al. (Applied for.)
6. Reduction of oxide or carbonate to slag-forming residues. (Applied for.)

The first process involves the production of metallic sodium, and we have been using the Castner process for this purpose to satisfy ourselves just what the sodium would cost and what the possibilities in this direction were. Existing conditions, the demand for sodium and sodium peroxide, forbid its consideration with a minimum of about 2 lb. of Na consumed for every pound of magnesium produced and the necessity of producing dehydrated fused $MgCl_2$ to start with.

The second process has been perfected and is very largely used abroad. We have commercially used and studied the process here, and with the cheapest water power and chloride, prices under normal conditions by this process must rule above $1.

The third process—reduction with carbon—is fascinating in its possibilities. The product is a black or gray powder. Believing such a product would be valuable, the manufacture was carried out on a scale of about 25 lb. per hour. As the difficulty of selling the product became apparent, much time and effort were devoted to attempts to recover the metal in fairly pure form. Owing to serious objection, both on the side of cost and regularity of product, this process was superseded.

At least one of the processes appears to be adapted to produce directly metal averaging 99.6% purity in tons per day instead of pounds. Laboratory tests give a raw-material cost of 4c. per lb. of magnesium, and indicate a fuel cost that approaches 3c. as a theoretical limit, though the practical figure will probably be several times as high. The final selection of various possible engineering means and methods remains to be worked out, but it scarcely seems possible that either labor or repairs should exceed 2c. per lb. Thus if commercial yields maintain the experimental level and three times the theoretical power is commercially required, we have prospects of a net factory operation cost (without interest, amortization, insurance, patent, administration or selling) of 17c. per pound. If only 75% yield is obtained, this net factory cost would be about 22c., or a total cost with all overhead expenses of 35c. and a selling price of 40c. to 50c., according to tonnage.

### The Future of the Industry

It may be asked with perfect propriety: "Why talk about it now? Some fool will certainly want you to make a contract with him at lower prices, possibly at 50c. He will not realize that it is only the present price of $5.50 that justifies or even makes possible the thousand and ten-thousand dollar experiments that have been tried and must be tried again and perhaps again during the next three to five years before the tide turns. You will be pestered for years with this 17c. talk." We have carefully considered this probability. The men who are doing this work do not cultivate talkativeness as a preference. Just at this time, however, certain considerations of public welfare should take precedence of preference. National self preservation demands the subordination of personal interest. If we expect representatives at Washington to jettison the pork barrel, the army post, the high-tide navy yard and political trading generally, and give us a fighting chance for our lives in the scrap that is certainly coming, we must set the example of considering national interest first. If we are to have the army and navy preparedness for which we have already wasted more money than Germany has paid for her wonderfully efficient fighting machine, if we are to have any preparedness instead of repairs or regrets, we must coöperate with all we have in service, information and suggestion.

Therefore, at the risk of criticism and possible financial sacrifice, it seems to be a duty at this time to point out what may possibly be expected of magnesium. Few realize the extent to which it is valuable in military work. One of the great foreign explosive experts stated that he would be glad to pay $1.50 per pound for 500 tons. A single contract for shrapnel being executed in this country would require about fifty tons. The illuminating bombs to make daylight over the enemies' works and trenches consume large quantities. The trailer attached to shells serves at night to show the effectiveness of the fire. For all these purposes magnesium produces a result that cannot be approached by antimony or aluminum. Consider what it means to aëroplane, dirigible and motor construction, to high-speed engines of every type, to reduce weight one-third and double strength—a material that has a density of 1.75 and may be hot-rolled to 35,000 lb. per sq.in. or cold-rolled very much higher.

Although five or six men are being kept practically all their time on the development of these possibilities, the broad, quick development is a task for the energy of hundreds. Feeling the responsibility which knowledge of the possibility entails, it became the duty of those in charge of this work to let others know and be active in their side of preparation, to apply the material.

## The Dorr Company

Announcement has been made of the incorporation of the Dorr Co., successor to the Dorr Cyanide Machinery Co. The expansion of the business has necessitated an enlargement of its engineering staff and facilities and made advisable the incorporation of the Dorr Co., which takes over the patents and commercial business of its predecessor and will act in a consulting capacity in connection with the design, construction and operation of hydrometallurgical, wet chemical and allied industrial plants and the conduct of technical investigations.

The history of the Dorr Co. begins with the Dorr classifier, which was developed by Mr. Dorr while operating the cyanide mill of Lundberg, Dorr & Wilson, at Terry, S. D., in 1904.

In 1910 the Dorr Cyanide Machinery Co. was incorporated, and in 1911 the London office of the company was established. The Dorr agitator was introduced in 1912.

The introduction of the continuous counter-current decantation system with the use of Dorr thickeners in cyaniding attracted attention, the first installation being made at the mill of the Vulture Mines Co. in Arizona. The further increase in the business led to the opening of a New York office about the end of 1913 and the expansion of the company's quarters in Denver. Mr. Dorr has remained continuously connected, during this development, with the operation of one or more mills. The company has recently financed, designed, erected and operated a mill for Elko Prince Mining Co. at Midas, Nev.

The consulting department of the Dorr Co., through keeping in close touch with the latest developments in metallurgy, is to render service in the design and erection of plants and the investigation of processes. It is also equipped to supervise the operation of a limited number of properties. Service of this kind is valuable not only to those property owners who are more interested in results obtained than in the type of equipment required to accomplish them, but also to those who do not find it possible to retain the entire services of men capable of efficiently designing or operating their plants. Metallurgical work will be handled principally at Denver, while industrial work will receive attention mainly at New York. The London office and the Australian agency will be maintained as before.

Among the recent additions of importance to the personnel of the company may be mentioned A. L. Blomfield, W. A. Neill and H. S. Coe.

## Proposed Nitric-Acid Plant

A proposal was submitted to the Secretary of War Mar. 29 by the E. I. du Pont de Nemours Powder Co., as follows, says the *New York Times.*

On frequent occasions during recent years General Crozier has called our attention to the menace involved by our dependence on foreign nations for our raw materials for nitric-acid supply, this commodity being absolutely essential in the manufacture of smokeless powder and other explosives and in great demand as an essential in the manufacture of fertilizers. Several years ago the fixation of nitrogen from the air by the use of the electric arc was found practicable abroad, and with a view of implanting the industry in this country (solving our problem here at home), the Du Pont company sent a corps of its experts to Europe to thoroughly investigate the various processes there employed. As a result of these investigations the Du Pont company purchased the right of one of the leading processes used abroad, which process is now established in Europe on a commercial basis on a large scale of production.

As you know, the process of securing nitric acid from the air requires large units of hydro-electric power at a very low cost. Coincident with our investigations abroad, we have been studying the possibilities for satisfactory hydro-electric power in the United States, and we find that while the power physically exists, it is not available because of governmental restrictions. I inclose herewith for your consideration a tentative draft of a bill which we believe will protect the public interest and justify the investment of the capital essential to the solution of this problem in the United States. You will note the bill we submit provides that the company "shall deliver to the United States for military or naval purposes all or any part of the output of nitric acid at a price which shall include such profit as the Secretary of War shall determine to be reasonable."

With the way made clear, the Du Pont company stands ready to negotiate a contract under which it will begin the construction of a plant under such unit and magnitude as may be agreed upon between the Government and the Du Pont company, the Du Pont company to furnish the capital.

Hugh L. Cooper, consulting engineer for the Du Pont company, estimates that the construction of the proposed plant would involve an investment of $20,000,000. The proposed law provides for grants or leases of power and dam sites in navigable streams or in the public lands for fifty years, the rates for power to be regulated by state commissions or by the Secretary of War.

At the end of the fifty-year term the Government is to have the option of taking over the plant upon payment of a fair value of the property, with no allowance for franchise value.

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## Reform of Mining Law

At the Northwest Mining Convention, held in Spokane Mar. 20-25, the following resolutions were passed:

Whereas, the mineral-land laws of the United States and Alaska, framed nearly 50 years ago, are unsuited to present needs and have developed various evils and radical defects that seriously retard or wholly prevent the development of our mineral resources; and

Whereas, in consequence of this recognized failure of present United States mining laws adequately to meet the requirements, there is everywhere among mining men a pronounced and growing dissatisfaction; and

Whereas, owing to the thoroughness with which our older mining districts have been surface-prospected, the discovery of new, valuable and, usually, more or less deep-seated mineral deposits is daily growing more difficult; and

Whereas, those states that have endeavored to correct certain of the defects in the said United States mining laws have found that patchwork legislation is impracticable and that nothing constructive and permanent can be done effectively without Congressional authority; and

Whereas, many unsuccessful attempts have been made in the past to interest Congress in this most important matter of mining-law revision; therefore, be it

Resolved by the 1916 Northwest Mining Convention, assembled at Spokane, Wash., that it is the conviction of this representative body of Northwest mining men that any further delay upon the part of Congress to take definite action in regard to an expert and comprehensive revision of United States mining law must inevitably work great hardship upon the mining industry as a whole and may even threaten its future. Consequently the convention hereby petitions that this sixty-fourth session of Congress appoint forthwith a mining-law commission of not less than five prominent persons closely and actively identified with the mining industry and thoroughly competent to take evidence in the principal mining centers of the United States and Alaska over a period of not less than one year, and afterward to work out, for presentation to the next session of Congress, a harmonious and thoroughly coördinated code of mining law that shall best serve and safeguard the present and future interests of all concerned.

Resolved, that it is the sense of this convention that the said commission should consist of at least one business man, one mine operator, one mining engineer and two mining lawyers, each of acknowledged ability and sound judgment; also, that the members of this commission should receive such adequate compensation for their services as would justify them in devoting their entire time and energies to a solution of the numerous problems involved.

Resolved, that it is the conviction of this convention that this revision of United States mining law cannot be accomplished successfully in any other manner than in that specified above, namely, by means of a duly accredited commission, and therefore that the House Committee on Mines and Mining did a wrongful act in rejecting the bill providing for a commission to study and recommend such revision and that any bill originating within the said House Committee on Mines and Mining will necessarily prove wholly inadequate and even more detrimental to the mining industry than are the present mining laws.

Resolved, that it is the conviction of this convention that the House Committee on Mines and Mining erred at its hearing on Jan. 5, 1916, and thereafter in permitting itself to be swayed by the arguments of Hon. James Wickersham, delegate from Alaska, whose challenges of the personal motives of the distinguished petitioners appearing before the committee, as representatives of the mining men of the so-called metalliferous states, this convention believes to have been unfounded and unjust.

Resolved, that copies of these resolutions be sent forthwith to the Senators and Representatives from the Pacific Northwest States with a request for their active interest in the matters involved.

F. A. ROSS, Chairman.
E. N. BRANDEGEE, for Montana.
GLENVILLE A. COLLINS, for Washington.
FRED A. STARKEY, for British Columbia.

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## Chronology of Mining for March, 1916

Mar. 1—Cerro de Pasco Copper Corporation and Barnes-King Development Co. paid initial dividends.

Mar. 2—Announcement of order of British government forbidding speculation in metals in London market.

Mar. 6—Reorganized Booth paid initial dividend.

Mar. 7—Northport Smelting and Refining Co.'s plant started operation.—Tin smelting begun by American Smelting and Refining Co. at Perth Amboy, N. J.

Mar. 9—Guggenheim Exploration Co. stockholders ratified plan of dissolution.—Villa followers invaded town of Columbus, N. M.; 16 Americans killed.

Mar. 12—Trimountain mill partly destroyed by fire.

Mar. 21—Carbolite Chemical Co. T. N. T. plant, owned by Tennessee Copper Co., destroyed by fire.

Mar. 23—Inspiration declared initial dividend.

Mar. 26—Yuba No. 15 dredge launched at Marysville, Calif.

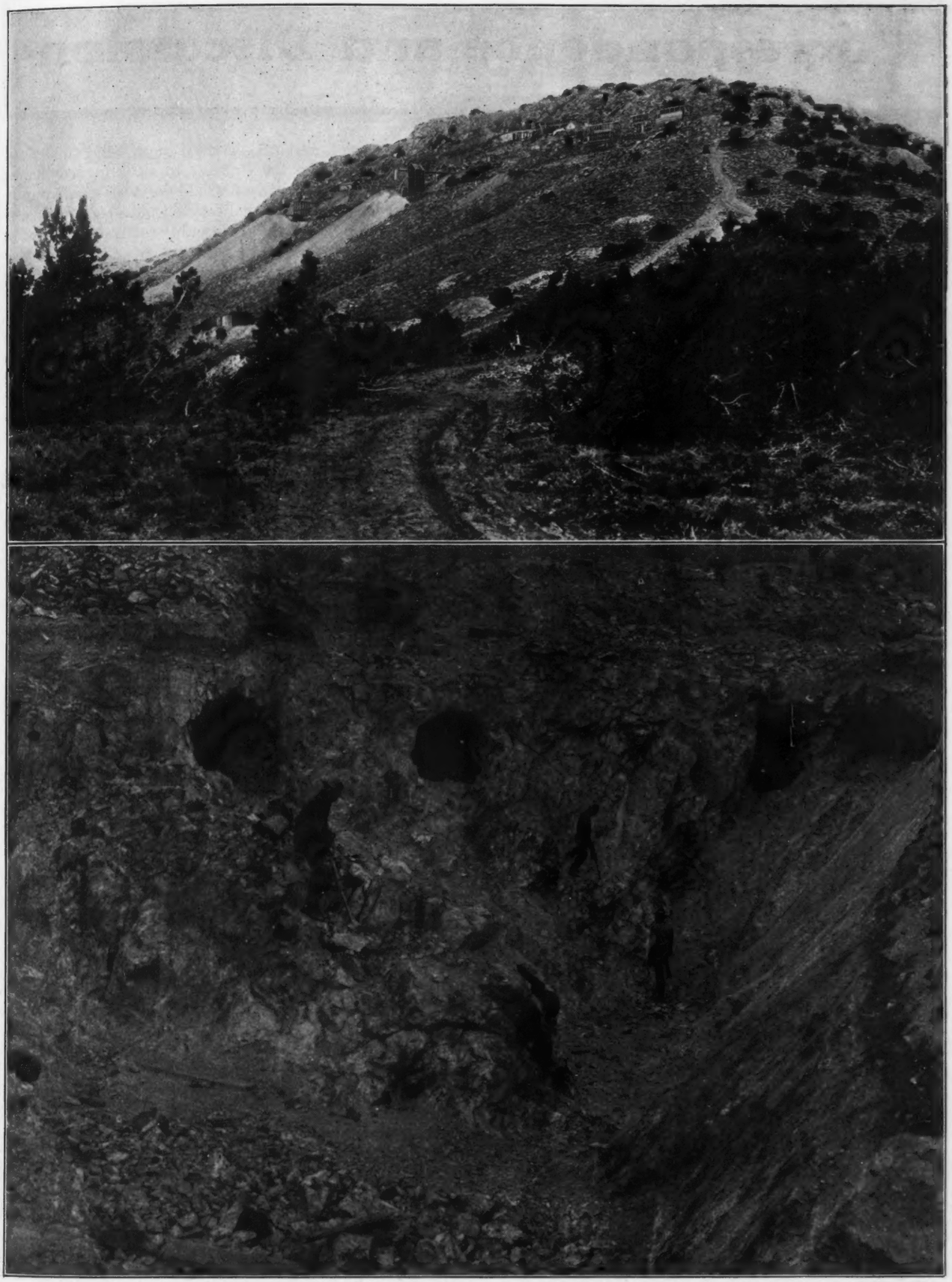
Mar. 28—American Zinc and Chemical Co. strike settled. Began Mar. 25.

Mar. 30—Kenefick Zinc paid initial dividend.—New York, New Haven & Hartford R.R. raised its embargo on copper and spelter.

Mar. 31—Kennecott Copper Corporation paid initial dividend.

# Photographs from the Field

OPEN SECTION OF GLORY HOLE OF BULLWHACKER MINE, BUTTE, MONT., SHOWING OPERATION OF HAMMER DRILLS FROM SUSPENDED LADDERS



ROCHESTER HILL, ROCHESTER, NEV., SHOWING OUTCROPPINGS OF THE FAMOUS SILVER VEINS. LOWER VIEW SHOWS AN OPENCUT BELONGING TO THE NEVADA PACKARD MINES CO., DEVELOPED BY LEASERS

# Correspondence and Discussion

## A Work of Reconstruction

The Belgian Scholarship Committee was founded about a year ago in Washington by the well-known author, scientist, and traveler, Dr. Nevil Monroe Hopkins. At first it confined its activities to the District of Columbia and its aim was simply to collect money for destitute scholars, but now its scope has become broader. The committee now includes among its members the presidents or chancellors of the following universities: Johns Hopkins, Princeton, Michigan, Missouri, Leland Stanford Jr., Pennsylvania, George Washington, State of New York, Nebraska, Rive Institute, Western Reserve—and many other leading men of this country. The aims of the Belgian Scholarship Committee are, first, to give to the Belgian scholars, writers and artists a chance to resume their work of art or science. To accomplish this aim the Belgian Scholarship Committee acts as a clearing bureau between the American universities and other educational institutions and the Belgian victims of the war; and, second, to raise a fund for the reconstruction of a new and better Belgium, especially in the educational field.

The first aim is only of a temporary nature; the second one becomes every day more important. Our ambition is to be ready, as soon as the war is over, to help in putting Belgium on her feet again for a new and greater career. We are appealing for books to the American libraries; we hope that they will be willing to give some of their duplicate copies and also that we shall receive free sets of their publications from the educational institutions and learned societies.

We cannot afford to store and keep the books until the end of the war. Therefore we do not ask for books but rather for promises of books. We suggest that the whole business be managed in the following way: Each library would simply send us a list of the books it is willing to give to Belgium. This list would contain all bibliographical information necessary to identify the books without mistake (author, title, number of volumes, date and place of publication, editor). We should acknowledge receipt of these lists and enter them on a duplicate list on cards. After the war, as soon as circumstances permit, the Belgian Scholarship Committee would write a letter to all the libraries, recalling their promise and asking them to send all the books to some central storehouse in New York City, from where they could easily be shipped to Belgium.

We shall concentrate our efforts upon the making up of a collection of American books—books published in America or relating to American affairs. We should thus be able to offer to Belgium, soon after the war, an American library. No gift would be more appreciated or do more to bring about a better understanding of American conditions and ideals and greater international friendship.

Of course books given by publishers and authors will also be welcome. We would suggest leaving in each book its former *ex-libris*, a short note being added to show how and when the transfer to Belgium was made. Dedications by the authors would be also much appreciated. The value of the collection would be in this way considerably increased. It would really constitute a lasting souvenir of America's generosity and sympathy.

We are also appealing for money. Money is needed to help Belgian scholars and artists; money is needed to carry on our activities; lastly we must be able to remit a huge reconstruction fund (to be used for educational purposes only) to the Belgian people when the war is over. We cannot expect to be helped by the general public, as with the general relief fund, but we earnestly appeal to the élite of the American people—to those who are especially interested in the development and diffusion of knowledge and art. The cause is such as to appeal in a peculiarly appropriate way to the best classes of Americans.

The best way to show one's sympathy is to become a fellow or member of the Belgian Scholarship Fund for the duration of the war and two years thereafter. The associate members agree to subscribe at least $10 per year; the sustaining members at least $100 and the fellows $1,000. Please draw checks to the order of John Joy Edson, treasurer, and send them to the Belgian Scholarship Committee, 309 Wilkins Building, Washington, D. C.

When the war is over the Belgian Scholarship Committee will publish a book containing a complete record of its activities and a list of the fellows and members whose devotion made it possible. We wish to lay stress upon the fact that ours is not simply a relief work. It is essentially a work of reconstruction, making for international friendship and peace.

GEORGE SARTON, D.Sc.,
Secretary of the Committee.

Washington, D. C., Mar. 30, 1916.

[This is a praiseworthy movement and we have pleasure in giving publicity to it.—Editor.]

## Mitchell Top-Slice and Caving System

In my article, "The Mitchell Top-Slice and Caving System," as published in the *Journal* of Mar. 25, some of the readers might misunderstand the article to describe but one method of mining; but as a matter fact—two distinct systems are represented.

The method used at the Cole mine is the "Mitchell Top-Slice and Caving System"; that described as used at the Briggs mine is the "Mitchell Top-Slice."

These names are very similar, but as a matter of fact the methods are quite different and are used on entirely different kinds of orebodies. One is a caving system, whereas the other is a modification of an overhand square-set method.

ROBERT H. DICKSON.

Box 1455, Bisbee, Ariz., Mar. 28, 1916.

# Editorials

## Military Preparedness

Early in the war we called attention to the idea that probably there was a good deal of unnecessary use of the metals by the military men, through thoughtless specifications, etc. A ray of light upon this subject is found in a communication from France in the New York *Sun*.

A weeding out of unnecessary governmental expenses takes place in the Chamber of Deputies every year when the report of the Audit Office is distributed to Parliament. Usually a score or more of conspicuous cases in which the public money has been wasted are selected by a committee which investigates them. A member of the Committee on Economy spent several hours endeavoring to find a reason why ammunition was sent to the front in zinc-lined cases. The other members of the committee and the Minister of Munitions were not able to solve the problem, so two members of the committee accompanied a box of cartridges from Vincennes to the front to ascertain the reason for the zinc. None was forthcoming, but after numerous fruitless interviews with army officers the general in command of the Fifth Army hit upon the reason. The zinc had been used for 60 years in ammunition boxes, and no one had ever thought to take it out. As a result an order was issued doing away with the zinc lining. As the zinc in each box is worth nearly $2, the saving during the war amounts to almost $150,000 a year.

In our opinion this indicates the most effective way for the engineering societies to render assistance to the military authorities of the United States. The measures that are being taken in the excitement of the present moment are largely at sixes and sevens. They are not laid out according to any definite plan. The logical way, we think, would be something like this:

The army general staff should determine the number of men to be put into the field in the worst possible contingency. No doubt it has done that already. It should draw up a complete bill of material for the supply of such an army. Perhaps it has done that, and perhaps not. That bill of material, together with the specifications, should then be referred to the U. S. Naval Consulting Board, representing the engineering societies, and by it should be cut up and distributed among the engineering societies—the metallurgical parts to the metallurgical engineers, the mechanical parts to the mechanical engineers, the chemical parts to the chemists, and so on. Those bodies would then subdivide things among their specialists. They would scrutinize the specifications, finding out whether certain things likely to be troublesome or costly were prescribed by reason of necessity or by reason of tradition; they would suggest substitutes and improvements. Having determined what was really needed, they would formulate plans for the supply of it, making a survey of the industries, listing industrial plants, etc., and recommending steps for the filling of gaps.

With such procedure we should not, some day, build a lot of submersible boats, urgently needed in an emergency, and at the eleventh hour and fifty-ninth minute find that they could not put to sea for lack of the optical glass required for their periscopes.

We imagine that the difference between German preparedness and British unpreparedness was something of this sort. No doubt the U. S. Naval Consulting Board is already considering just this thing, as it ought to. By the way "U. S. Naval Consulting Board" is too narrow a title. It ought to be the "U. S. Military Advisory Board."

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## Metal-Mine Accidents

The United States Bureau of Mines has been developing its statistical investigation of accidents in mines in ways that promise to make classics out of its annual reports on this subject. Already they have become more illuminating than any other governmental reports of this kind that we know of, and Mr. Fay, who is attending to this work, is seeking constantly to improve his investigation. In commenting upon one of his former reports we recommended a classification of accidents according to methods of mining. This suggestion was adopted in the report for 1914. The section on "Accidents Classified by Mining Methods" is reproduced elsewhere in this issue, this initial presentation of the subject being of unusual interest and value to mine operators.

The figures reveal some expected and some unexpected results. It will be necessary, however, to have these statistics for a series of years before complete deductions respecting the relative hazards of different kinds of mining may safely be drawn.

Along with Mr. Fay's report came the report of the safety department of the Copper Queen company for 1915. In many respects this is the most instructive report on mine accidents that has come to our attention, going as it does into a kind of detail that even a government report can not do.

The Copper Queen company organized a safety department a little more than two years ago. In 1915 its fatal accidents were only 1.05 per 1,000 against 3.16 in 1914; serious accidents, 63.38 against 104.41; and minor accidents, 838.65 against 995.29. There is a remarkably minute classification of accidents according to cause. Even more interesting is the division into preventable and nonpreventable. In 1915 the former were 68%, the latter 32%. The nonpreventable accidents are like eye injuries, strains and sprains inherent to the work—in other words, trade risks. Of the preventable accidents, out of a total of 1,168 the company was responsible for 20, the injured employee himself was responsible for 1,062, while 86 were due to the negligence of a fellow employee. Bearing upon these matters the following trenchant remarks are worthy of being quoted:

Following the outbreak of the European War many men were laid off. To bring the mines up to their normal production, which was done in the early part of this year, it was necessary to replace many of these with new men. New men are a risk, and our records show that a larger proportion of these received accidental injuries than did the older employees.

Note that 89% of all eye injuries and 81% of the strains and sprains are classed as trade risks and that these constitute 18% of all accidents. These injuries are hard to prevent, especially underground. Also, that 59% of the hurts received from falling ground were trade risks. Accidents from this cause have been greatly reduced, but they still

form the greatest danger that underground workers in this district have to face.

The physical examination of new employees is providing the company with a better class of men—men who have no organic disease, consequently less liable to accident. Just what effect this does have it is impossible to say; that it has some, I am convinced.

What effect prohibition, as enforced in this district during the past year, has had in reducing accidents is very hard to say. It is my candid opinion that it has had very little. The greatest gain from the closing of the open saloon (that being all that the prohibition amendment has done, liquor being as plentiful as ever) is in the added efficiency of the social drinker, through less loss of time and increase in his physical well-being.

Another thing that should be a help in reducing accidents is the fact that more married men are in the employ of the company than formerly. Men with families, having more responsibilities, naturally take better care of themselves.

Wallace M'Keehan, safety inspector for the Copper Queen Consolidated Mining Co., is certainly approaching his important work with a high degree of intelligence.

## The Lead Smelters

On Mar. 31 the Bunker Hill & Sullivan Mining and Concentrating Co. announced its final decision to build its new smeltery at Kellogg, Idaho. There had been a long consideration of the relative merits of Kellogg, where the mine is situated, and some point on the Pacific Coast. The questions of fuel, fluxes and freight rates were of course prime factors. In the meanwhile the ironwork for the furnaces had been in process of manufacture at Allentown, Penn., wherefore no time was being lost on that account.

The entry of the Bunker Hill & Sullivan company into the lead-smelting business is going to add greatly to the interest and competition in that business, in which the American Smelting and Refining Co. has gradually been losing its predominance. Inasmuch as several of the large producers now publish their production figures in their official reports, a comparison of them with the total production may be made.

The total production of lead in the United States, both from domestic and foreign sources, was 615,253 tons, as reported in the *Journal* of Jan. 8, 1916, compared with 568,329 tons in 1914. Since then three important companies have reported the following outputs and we have computed their proportion to the whole:

| | 1914 | | 1915 | |
|---|---|---|---|---|
| Company | Tons | % | Tons | % |
| A. S. & R. Co..... | 316,591 | 55.7 | 296,986 | 48.2 |
| St. Joseph ..... | 77,404 | 13.6 | 84,356 | 13.7 |
| U. S. Smg. Co..... | 32,222 | 5.6 | 43,551 | 7.0 |

Besides the American Smelting and Refining Co., the St. Joseph Lead Co. and the United States Smelting Co., the other important producers are the Anaconda (International), the Balbach Smelting and Refining Co. (Ohio & Colorado), the Pennsylvania Smelting Co., the St. Louis Smelting and Refining Co. (National Lead Co.), the Picher Lead Co. and the Granby Mining and Smelting Co. The refinery of the Pennsylvania Smelting Co. was recently acquired by the interests owning the Hercules mine in the Cœur d'Alene, which also acquired and rebuilt the old smeltery at Northport, Wash. Inasmuch as the Hercules was a very large producer, the smelting of whose ore recently passed away from the American Smelting and Refining Co., a new and powerful competitor is coming into the market from that quarter.

With the loss of the Hercules and Bunker Hill & Sullivan ores, the proportion of the lead output of the American Smelting and Refining Co., which in 1915 fell below 50% of the total, will become still less. For some years back there has been sharp competition both in the selling of lead and in the buying of lead ore. It is evident that that condition is going to become even more intense.

## Reform of the Mining Law

If we judge correctly from the Western papers, Doctor Foster's bill is meeting with the same condemnation that the *Journal* gave to it. It is clearly the general opinion that this well-meant but preposterous proposal would simply make matters worse than they are now. It would be better to leave the existing laws untouched than to substitute what Doctor Foster has drafted, or even to try to re-dress his skeleton. It was with full knowledge of how difficult a thing it would be to frame a new satisfactory mining law that the engineering and mining societies and organizations united unanimously in recommending Congress to authorize a commission to study the subject.

The representatives of the Mining and Metallurgical Society of America who appeared before the House Committee on Mines and Mining returned from Washington with the idea that a mistake had been made in trying to get Congress to authorize a commission—not a mistake from the theoretical standpoint, but probably a mistake from the practical. The average member of Congress has no conception of the nature of the work of an advisory technical committee or commission, and perhaps he will not have an accurate idea inside of the next 50 years. There is, moreover, among Congressmen a spirit of perversity that leads the representatives of the people to conceive that a gift of clairvoyance and superintelligence was bestowed upon them by success at the polls and causes them to belittle the assistance and disregard the advice of experienced men.

The Mining and Metallurgical Society is now going to undertake the drafting of a new law. The bill will be introduced in Congress by a distinguished Senator as soon as it is ready. Before that is done, however, it is aimed to give the widest possible publicity to what is proposed and to what is being considered, inviting the criticism and suggestions from everybody who is interested in the welfare of the mining industry. It is desired to frame something simple and practicable and something that will meet with the approval of mining men in great majority. It is hoped that it will be possible to introduce a skeleton of a bill at the meeting of the society in New York on Apr. 19, which meeting promises to be largely attended. The proceedings will be published in the *Engineering and Mining Journal* immediately afterward, and general discussion will be invited.

German steel production in 1915 was apparently well maintained, the total being over two-thirds that of 1913, the year of highest production. The changes in the final form of manufactured steel have doubtless been great, though we are not yet informed as to their exact nature. The consumption of steel in war munitions must have been very large and has made up for the ordinary uses from which the metal has been diverted, but not for the quantities which would have been exported in various forms in a normal year.

## BY THE WAY

Although the Steel Corporation's mills were working part of last year under great pressure, some exceeding the rated capacity by 10%, the annual report shows "extraordinary replacements and general rehabilitation" required 30.6% less expenditure than in 1914, and the total costs of maintenance and general upkeep were 4.4% under the preceding year, despite a greatly increased output. Commenting on this, the *Times Annalist* says it upholds the ancient adage that a plant working full goes back more slowly than one only partly filled.

Almost everyone in Colorado has the "tungsten fever," and claims are being staked on every streak of dark-colored mineral that cannot be named offhand by the discoverer. The latest freak discovery was made by a locomotive engineer employed by the Denver, Boulder & Western R.R., who has made this run for many years. A few days ago, for the first time, a black streak in a cut below Glacier Lake caught his eye as the train sped along. He promptly stopped the train, backed up to the cut, climbed out of the cab and posted a notice. He then brought the train into Boulder on time. Rumor has it that this may be one of the most valuable tungsten deposits in Colorado.

W. L. Saunders, past president of the American Institute of Mining Engineers, is being strongly urged in New Jersey to stand as Democratic candidate for United States Senator to succeed Mr. Martine. Mr. Saunders has so far emphatically resisted all persuasion. He has taken the ground that as vice-chairman of the United States Naval Consulting Board he is rendering the most important service possible to the country, and that it would not be right for him to abandon that work in the present juncture. His friends will appreciate this attitude. Nevertheless, they will think, just as we do, that Mr. Saunders is exactly the kind of man who ought to be a United States Senator.

The *New Republic,* which is a "journal of opinion," recently made some rather outrageous remarks about the attitude of the mining companies in the late strike at Clifton-Morenci. This led Walter Douglas to address a letter to it, correcting some of its errors. We gather that the *New Republic* is of the opinion in this case that during the time while the mine managers were exiled from the district the striking miners were gently diverting themselves with pink teas and other innocent amusements. Mr. Douglas submits evidence to the contrary, whereupon the editors of the *New Republic* inform him that he, being the general manager of the principal company, does not know what he is talking about. Why, they are informed that he was not in the strike district at any time during the strike, while they themselves have very reliable information! In effect they tell Mr. Douglas to quit his quibbling. The large concentrating mill that was destroyed by fire while in the sheriff's custody, simply burned up of itself. Probably defective electric insulation did it. In regard to one important matter, however, these wise editors admit that later investigation by impartial men indicates that their informants were in error and that Mr. Douglas is correct. We advise them to do some more impartial investigating. O Lord, deliver us from these half-baked high-brows who let their legs be pulled by Moyer, Haywood and the others of that ilk!

## March Mining Dividends

Dividends paid in March, 1916, by 39 United States mining companies making public reports amount to $20,743,544 as compared with $4,922,039 paid by 29 companies in March, 1915. Industrial and holding companies allied to mining paid $13,741,712, as compared with $5,317,112 in 1915. Canadian and South American mining companies paid $1,922,642 in March, 1916, and $630,382 in March, 1915.

| United States Mining Companies | Situation | Per Share | Total |
|---|---|---|---|
| Argonaut, Con., g | Calif. | $0.10 | $20,000 |
| Arizona Copper, com., c | Ariz. | 1s 3d | 461,658 |
| Barnes-King Dev | Mont. | .075 | 30,000 |
| Bunker Hill & Sullivan, l.s | Idaho | .50 | 163,500 |
| Butte & Superior, z | Mont. | 10.75 | 2,925,194 |
| Caledonia, l.s | Idaho | .03 | 78,150 |
| Calumet & Arizona, c | Ariz. | 2.00 | 1,234,770 |
| Calumet & Hecla, c | Mich. | 15.00 | 1,500,000 |
| Champion, c | Mich. | 2.00 | 200,000 |
| Chino, c | Ariz. | 1.25 | 1,087,475 |
| Con. Interstate-Callahan, z | Idaho | 1.50 | 690,000 |
| Copper Range, c | Mich. | 1.50 | 542,249 |
| Federal Min. & Smelt., pfd | Idaho | 1.00 | 119,861 |
| Golden Cycle, g | Colo. | .02 | 30,000 |
| Hecla, l.s | Idaho | .10 | 100,000 |
| Hercules, l.s | Idaho | .20 | 200,000 |
| Homestake, g | S. D. | .65 | 163,254 |
| Jumbo Ex., g | Nev. | .075 | 116,250 |
| Kenefick Zinc, z | Mo. | .10 | 20,000 |
| Kennecott, c | Alaska | 1.00 | 2,780,099 |
| Magma, c | Ariz. | .50 | 120,000 |
| National Zinc & Lead, z.l | Mo. | .04 | 20,000 |
| Nevada Con., c | Nev. | .50 | 999,728 |
| New Idria, q | Calif. | 1.00 | 100,000 |
| North Butte, c | Mont. | .50 | 215,000 |
| North Star, g | Calif. | .20 | 50,000 |
| Old Dominion, c | Ariz. | 2.50 | 405,000 |
| Oroville, g | Calif. | 6d | 82,380 |
| Prince Con., l.s | Nev. | .025 | 25,000 |
| Quincy, c | Mich. | 3.00 | 330,000 |
| Raven Copper | Mont. | .26* | 163,800* |
| Ray Con, c | Ariz. | .50 | 730,401 |
| Reorg. Booth, g | Nev. | .05 | 50,000 |
| St. Joseph Lead | Mo. | .25 | 352,350 |
| Success, z | Idaho | .03 | 45,000 |
| United Globe, c | Ariz. | 15.00 | 345,000 |
| United Verde, c | Ariz. | .75 | 225,000 |
| Utah Copper | Utah | 2.50 | 4,061,225 |
| Yellow Pine, l.g.s.z | Nev. | .10 | 100,000 |
| Wasp No. 2, g | S. D. | .05 | 25,000 |
| **Metallurgical and Holding Companies** | **Situation** | **Per Share** | **Total** |
| Am. Smelt. Sec., pfd. A | U. S. | $1.50 | $249,747 |
| A. S. & R. Co., com | U. S. | 1.00 | 501,080 |
| A. S. & R. Co., pfd | U. S. / Mex. | 1.75 | 875,000 |
| Dominion Iron & Steel, pfd | N. S. | 2.00 | 140,000 |
| General Development | U. S. | 1.25 | 37,485 |
| International Nickel, com | U. S. | 5.00 | 2,091,632 |
| National Lead, com | N. Y. | 1.00 | 206,554 |
| National Lead, pfd | N. Y. | 1.75 | 426,433 |
| Phelps, Dodge & Co | U. S. | 6.00 | 2,700,000 |
| St. Mary's Min. Land | Mich. | 1.00 | 160,000 |
| U. S. Steel Corp., com | U. S. | 1.25 | 6,353,781 |
| **Canadian and South American Companies** | **Situation** | **Per Share** | **Total** |
| Canadian Min. Corp., s | Ont. | 9d | $275,243 |
| Cerro de Pasco, c | Peru | $1.00 | 666,667 |
| Dome Mines, g | Ont. | .50 | 250,000 |
| Hedley Gold, g | B. C. | .50 | 60,000 |
| Hollinger, g | Ont. | .40 | 240,000 |
| Kerr Lake, s | Ont. | .25 | 150,000 |
| Le Roi, No. 2, g | B. C. | .30* | 36,450* |
| Nova Scotia Coal & Steel, pfd | N. S. | 2.00 | 21,200 |
| Peterson Lake, s | Ont. | .0175 | 63,000 |
| Right of Way Mines, s | Ont. | .05 | 84,275 |
| Standard Silver-Lead, s.l | B. C. | .025 | 50,000 |
| Temiskaming, s | Ont. | .03 | 75,000 |
| Yukon Gold, g | Yukon | .075 | 262,500 |

* Liquidation dividend.

The dividends paid by the Cerro de Pasco, Kennecott, Barnes-King, Kenefick Zinc, and Reorganized Booth were initial dividends by these companies.

The totals for the first three months of the year are as follows: Mining companies, 1916, $36,081,497 as against $9,520,928 in 1915; metallurgical and holding companies, 1916, $26,286,008, as against $15,896,449 in 1915; Canadian, Mexican, Central and South American mines, 1916, $6,120,404, as against $2,434,364 in 1915.

# NEW PATENTS

United States patent specifications listed below may be obtained from "The Engineering and Mining Journal" at 25c. each. British patents are supplied at 40c. each.

ALKALI METALS—Method for the Manufacture of Chlorates and Perchlorates of Alkali Metals. Arthur E. Gibbs, Wayne, Penn. (U. S. No. 1,173,346; Feb. 29, 1916.)

ALUMINUM—Process of Treating Aluminum Skimmings, Screenings, Slags, or Analogous Materials. Paul R. Hersman, Milwaukee, Wis., assignor, by mesne assignments, to William F. Jobbins, Inc., Aurora, Ill. (U. S. No. 1,176,292; Mar. 21, 1916.)

ALUMINUM ALLOYS. Walter N. Naylor, Forest Hill, London, and Stanley P. Hutton, Beckenham, England. (U. S. No. 1,175,655; Mar. 14, 1916.)

ALUMINUM NITRIDE—Process and Apparatus for the Manufacture of Aluminum Nitride. Soc. Gen. des Nitrures, Paris, France (Brit. No. 11,271 of 1915.)

BAUXITE DIGESTER. Henry Howard, Brookline, Mass. (U. S. No. 1,175,147; Mar. 14, 1916.)

CHROMIUM ALLOYS. Wilbur B. Driver, East Orange, N. J. (U. S. No. 1,175,724; Mar. 14, 1916.)

CONCENTRATE-PREPARING MACHINE. Thomas J. Lovett, Chicago, Ill., assignor to Copper Process Co., Chicago, Ill. (U. S. No. 1,175,782; Mar. 14, 1916.)

CONVEYOR BELT. Francis Lee Stuart, Baltimore, Md. (U. S. No. 1,175,190; Mar. 14, 1916.)

COPPER—Process of Concentrating Copper Values. Richard M. Atwater, Jr., Scarsdale, N. Y. (U. S. No. 1,175,331; Mar. 14, 1916.)

COPPER—Process for Electrodeposition of Copper. Stephen C. Babcock, Hamburg, and Elmer W. Hagmaier, Lackawanna, N. Y. (U. S. No. 1,174,466; Mar. 7, 1916.)

CRUSHER—Ore and Stone Crusher. Joseph E. Kennedy, New York N. Y. (U. S. No. 1,176,835; Mar. 28, 1916.)

CRUSHING—Disk for Crushing Machines. Edgar B. Symons, Chicago, Ill., assignor to Symons Brothers Co., Chicago, Ill. (U. S. No. 1,175,904; Mar. 14, 1916.)

CRUSHING—Dust Guard for Gyratory Crushing and Pulverizing Machines. Joseph E. Kennedy, New York, N. Y. (U. S. No. 1,176,834; Mar. 28, 1916.)

CRUSHING—Lubricated Bearing for Crushing and Pulverizing Machines. Joseph E. Kennedy, New York, N. Y. (U. S. No. 1,176,833; Mar. 28 1916.)

DIPPER TOOTH. John O'Fallon Clark, Jr., St. Louis, Mo., assignor to American Manganese Steel Co., Augusta, Me. (U. S. No. 1,176,275; Mar. 21, 1916.)

DREDGE—Dipper Dredge. William F. Hunter, Arcata, Calif. (U. S. No. 1,177,108; Mar. 28, 1916.)

DREDGE BUCKET. Wesley G. Nichols, Chicago Heights, Ill., assignor to American Manganese Steel Co., Chicago, Ill. (U. S. No. 1,176,976; Mar. 28, 1916.)

DRILL—Rock Drill. Albert Ball and Thomas Officer, Claremont, N. H., assignors, by mesne assignments, to Sullivan Machinery Co., Boston, Mass. (U. S. No. 1,176,708; Mar. 21, 1916.)

DRILLING APPARATUS. George H. Gilman, Claremont, N. H., assignor to Sullivan Machinery Co. Boston, Mass. (U. S. No. 1,175,745; Mar. 14, 1916.)

DRILLS—Improvements in Hammer Rock Drills. W. E. Kimber, Kent, Eng. (Brit. No. 4,730 of 1915.)

DRILLS—Tool Retainer for Percussive Hammers. Charles Christiansen, Gelsenkirchen, Germany. (U. S. No. 1,176,343; Mar. 21, 1916.)

ELECTRIC FURNACE. Ingenuin Hechenbleikner, Charlotte, N. C., assignor to Southern Electro Chemical Co., New York, N. Y. (U. S. No. 1,173,960; Feb. 29, 1916.)

ELECTRIC FURNACE—Tilting Electric Furnace for Smelting and Refining Metals. F. Bassanese, Milan, Italy. (Brit. No. 1,173 of 1915.)

FLOTATION—Improvements in or Relating to Ore Concentration. A. H. Higgins and Minerals Separation, Ltd., London, England. (Brit. No. 19,855 of 1914.)

FLOTATION—Machine for Reducing Ores, Etc. Thomas J. Lovett, Chicago, Ill., assignor to Copper Process Co., Chicago, Ill. (U. S. No. 1,175,966; Mar. 21, 1916.)

FLOTATION—Process of Concentrating Ores. Ernest Gayford and George Crerar, Salt Lake City, Utah, assignors to Metals Recovery Co., Augusta, Me. (U. S. No. 1,176,441; Mar. 21, 1916.)

FUEL—Apparatus for Drying Fuel. Herman Hermansen, Baybridge, Ohio, assignor to Sandusky Portland Cement Co., Baybridge, Ohio. (U. S. No. 1,173,510; Feb. 29, 1916.)

FUEL CONTAINING SPENT FULLERS' EARTH. Nathan Sulzberger, New York, N. Y. (U. S. No. 1,174,199; Mar. 7, 1916.)

FUEL—Means for Supplying Comminuted Fuel to Furnaces. John R. Magarvey, William Dalton and Charles L. Heisler, Schenectady, N. Y. (U. S. No. 1,177,045; Mar. 28, 1916.)

FUEL-AGITATING MEANS FOR FURNACES. Lewis Metesser New Orleans, La. (U. S. No. 1,177,430; Mar. 28, 1916.)

FURNACE. Walter S. Rockwell, New York, N. Y., assignor to W. S. Rockwell Co., New York, N. Y. (U. S. No. 1,177,058; Mar. 28, 1916.)

FURNACE—Metallurgical Furnace. Lewis Metesser, New Orleans, La. (U. S. No. 1,177,429; Mar. 28, 1916.)

FURNACE—Open-Hearth Furnace. Regnier Eickworth, Dortmund, Germany. (U. S. No. 1,176,744; Mar. 28, 1916.)

FURNACE CHARGING—Process and Apparatus for Charging Furnaces. Leslie Douglass Anderson, Midvale, Utah, assignor to United States Smelting, Refining and Mining Co. (U. S. No. 1,176,878; Mar. 28, 1916.)

FURNACE-CHARGING APPARATUS. Eugene A. Rudolf and William W. Doolittle, Chicago, Ill., assignors to Crane Co., Chicago, Ill. (U. S. No. 1,177,143; Mar. 28, 1916.)

GAS-ANALYZING APPARATUS. George A. Burrell, Pittsburgh, Penn. (U. S. No. 1,176,199; Mar. 21, 1916.)

GOLD RECOVERY—Process for Recovering Gold from Concentrates. Frederick B. Sanford, Dothan, Ore. (U. S. No. 1,176,858; Mar. 28, 1916.)

GRINDING MILL. Edwin C. Griffin, deceased, Newton, Mass., by Lovina M. Griffin, executrix, Brighton, Mass., assignor to Bradley Pulverizer Co. (U. S. No. 1,175,436; Mar. 14, 1916.)

HEATER for Mining and for Other Purposes. John Robert Quain, London, England. (U. S. No. 1,174,444; Mar. 7, 1916.)

HOT-AIR STACK. Albert G. Scherer, Chicago, Ill., assignor to Excelsior Steel Furnace Co., Chicago, Ill. (U. S. No. 1,175,306; Mar. 14, 1916.)

HOT-BLAST STOVE APPLIANCE. Frederick H. N. Gerwig, Braddock, Penn. (U. S. No. 1,175,629; Mar. 14, 1916.)

HYDROMETALLURGY. Edward R. Holden, Los Angeles, Calif. (U. S. No. 1,175,867; Mar. 14, 1916.)

JIG—Pulsator Riffle Jig. Robert H. Richards, Boston, Mass. (U. S. Pat. No. 1,176,403; Mar. 21, 1916.)

LAMP—Electric Miners' Lamp. Wilhelm Hickmann, Griesheim, near Frankfort-on-the-Main, Germany, assignor to Chemische Fabrik Griesheim Elektron, Frankfort-on-the Main, Germany. (U. S. No. 1,174,146; Mar. 7, 1916.)

LAMP—Miners' Safety Lamp. William Best, Morley, near Leeds, England. (U. S. No. 1,176,423; Mar. 21, 1916.)

LEAD ARSENATE—Method of Making Lead Arsenate. Lee Shepherd, Cleveland, Ohio, assignor to The Harshaw, Fuller & Goodwin Co., Cleveland, Ohio. (U. S. No. 1,175,565; Mar. 14, 1916.)

MATTE REFINING—Process of Refining Leady Matte. Noak Victor Hybinette, Christiania, Norway. (U. S. No. 1,175,266; Mar. 14, 1916.)

METAL OXIDES AND HYDROXIDES, Process for the Recovery of. Arnold Otto Blickle, Frankfort-on-the-Main, Germany, assignor to the Corporation of Metallbank und Metallurgische Gesellschaft A. G., Frankfort-on-the-Main, Germany. (U. S. No. 1,175,587; Mar. 14, 1916.)

MINE CAR. James E. Renshaw, Coalburg, Ala., assignor of one-half to Ed. Moore, Birmingham, Ala. (U. S. No. 1,175,178; Mar. 14 1916.)

MINE CAR. Malcolm S. Simpson, Pittsburgh, Penn., assignor to Pressed Steel Car Co., Pittsburgh, Penn. (U. S. No. 1,176,782; Mar. 28, 1916.)

MINE-CAR STOP—Automatic Mine-Car Stop and Release. William K. Anderson, Worden, Ill. (U. S. No. 1,176,123; Mar. 21, 1916.)

MINING-CAR WHEEL. Alfred Bryant Day, Knoxville, Tenn. (U. S. No. 1,173,179; Feb. 29, 1916.)

MINE-CAR WHEEL and Bearing. James J. Roby, Cleveland, Ohio. (U. S. No. 1,173,218; Feb. 29, 1916.)

NITROGEN—Fixation of Nitrogen. Herbert Raymond Moody and Samuel Auchmuty Tucker, New York, N. Y. (U. S. No. 1,175,007; Mar. 14, 1916.)

OIL—Process of Preparing Creosote Oil. George Albert Cook, Kansas City, Mo. (U. S. No. 1,176,345; Mar. 21, 1916.)

ORE REDUCTION—Improvements in the Direct Reduction of Iron and Other Ores. C. A. M. Buckley, R. C. V. Whitfield and E. V. Clark. (Brit. No. 23,669 of 1914.)

ORE TREATMENT—Desulphurizing Method for Treating Refractory Ores. Edward Hale Dickie, Goldroad, Ariz. (U. S. No. 1,177,396; Mar. 28, 1916.)

ORE TREATMENT—Preliminary-Treatment Tank. Edward Hale Dickie, Goldroad, Ariz. (U. S. No. 1,177,394; Mar. 28, 1916.)

PERCUSSIVE TOOL. Charles H. Haeseler, Philadelphia, Penn. (U. S. No. 1,176,443; Mar. 21, 1916.)

PLACER MACHINE. John Conley, Denver, Colo. (U. S. No. 1,176,735; Mar. 28, 1916.)

POTASH—Recovery of Potash from Calcined Alunite. Carl F. Hagedorn, Chicago, Ill., assignor to Mineral Products Corporation, New York, N. Y. (U. S. No. 1,175,439; Mar. 14, 1916.)

PRECIPITATING APPARATUS. Joseph Irving, Jr., Douglas, Ariz., assignor to the Dorr Cyanide Machinery Co., Denver, Colo. (U. S. No. 1,177,109; Mar. 28, 1916.)

PROPS—A Method for Removing Pit Props or Supports in Mines and Apparatus Therefor. F. Sommer, Essen-Ruhr, Germany. (Brit. No. 1,188 of 1915.)

QUARRYING—Electric Channeling Machine. Albert Ball, Claremont, N. H., assignor, by mesne assignments, to Sullivan Machinery Co., Boston, Mass. (U. S. No. 1,174,223; Mar. 7, 1916.)

RESCUE APPARATUS—Mine Breathing Apparatus. William E. Gibbs, New York, N. Y. (U. S. No. 1,176,711; Mar. 21, 1916.)

REVERBERATING FURNACES—Improvements in Reverberating Furnaces and the Like. A. Payne, W. Smith, J. T. Smith, F. J. Smith and S. B. Smith. (Brit. No. 4,948 of 1915.)

ROASTING KILN Having Superposed Vaulted Hearths. Jacob Lutjens and Wilhelm Ludewig, Hanover, Germany. (U. S. No. 1,176,070; Mar. 21, 1916.)

SEPARATOR—Ore Separator. George H. Davis, Worcester, Mass., assignor to Amerige-Davis Machine Co., Boston, Mass. (U. S. No. 1,175,616; Mar. 14, 1916.)

SILICATES—Manufacture of Soluble Silicates. Jacob Wm. Spensley and John W. Battersby, Manchester, England. (U. S. No. 1,176,613; Mar. 21, 1916.)

## PERSONALS

Walter Strache has returned to New York from Brazil.

W. E. Malm, of the Malm-Wolf Co., Denver, Colo., recently examined property in British Columbia.

John Seward is now in Arkansas investigating a zinc property. He expects to be in New York early in April.

C. A. Burdick has returned to New York from Virginia where he has been for a fortnight investigating manganese prospects.

H. R. Plate sails for Europe Apr. 8 on the steamer "New Amsterdam." He will be abroad several months on examination work.

Charles Mentzel left New York on Apr. 4 for San Pedro, N. M., to become manager of the Santa Fe Gold and Copper Mining Co. there.

Mark Workman, president of the Dominion Steel Corporation, is making a trip of inspection to the company's steel and coal properties.

Dr. W. A. Rittman has resigned his position with the U. S. Bureau of Mines to take a position as head of a company being organized for the purpose of manufacturing gasoline.

J. B. Cord, of Chicago, and G. B. Shipley, of Pittsburgh, have devised a new type of preserving plant for wood, which is claimed to be cheaper in first cost and more simple in operation than any other.

Chester A. Fulton has opened offices in Havana and Pinar del Rio as consulting mining engineer for the examination and management of mining properties on the island of Cuba. Mr. Fulton has had extensive experience in Mexico, Central and South America.

Lawrence Cooney, who recently joined the Algoma Steel Co. at Sault Ste. Marie, Ont., has been appointed general superintendent of the works and docks of that company. He was formerly in charge of the finishing department of the Ohio works of the Carnegie Steel Co., at Youngstown.

E. L. Goldschmidt and C. P. Lyman, for a number of years with the Waclark Wire Co., New York City, have resigned and formed a company under the name of Goldschmidt & Lyman, Inc., to conduct a brokerage business in raw metals and manufactured metal products at 90 West St., New York.

Charles R. Holton, since 1906 private secretary of J. V. W. Reynders, who recently resigned as vice-president of the Pennsylvania Steel Co. and general manager of its Steelton plant, has been made assistant to W. M. Tobias, purchasing agent for the Bethlehem Steel Co., at South Bethlehem, Penn.

The following changes have taken place in the staff of El Tigre Mining Co., at Esqueda, Sonora, Mexico: W. R. Maycumber, formerly mill superintendent, has resigned to accept a similar position in Chile. W. A. Wasley has been promoted to mill superintendent. H. W. Foester has been made cyanide foreman.

Frank F. Marquard, superintendent of the byproduct coke and benzol plant at the Farrell works of the Carnegie Steel Co., has resigned to become general manager of the new byproduct coke plant being erected by the same company at Clairton. He is succeeded at Farrell by Ellis Hilborn, formerly assistant manager.

Ernest McCullough, for many years a consulting engineer who has specialized largely on reinforced-concrete design and construction, has recently become identified with the Portland Cement Association, 111 West Washington St., Chicago. Mr. McCullough will be known officially as chief engineer, Fireproof Construction Bureau.

M. R. Hull, who for the last seven years has been connected with the engineering department of the Anaconda Copper Mining Co., at Anaconda and Great Falls, has resigned his position as superintendent of construction at the Washoe reduction works, to accept the position of chief engineer of the Arizona Copper Co., with headquarters at Clifton, Ariz.

C. A. Lunn, director of the flotation oils department of the General Naval Stores Co., New York, left this week for an extended trip through Colorado, Utah, Idaho, Montana and Nevada. Mr. Lunn, who is a chemical engineer, has been actively engaged for several years in developing oils for flotation work and his present trip is for the purpose of checking up the oils which his company now has in use throughout the West and to accumulate information for the development of new oils.

## OBITUARY

James Arthur died at Dover, N. J., Apr. 4, aged 72 years. He was engaged in iron mining in Morris and Sussex counties for many years and was for a long time superintendent of the old Richard mine.

Max M. Suppes died at Elyria, Ohio, Mar. 27, aged 69 years. He was born and brought up at Johnstown, Penn., learning the machinist trade. For about 10 years he was associated with Robert W. Hunt at the Rensselaer Steel Works at Troy, N. Y., as master mechanic and had much to do with designing improved rail mills. In 1888 he returned to Johnstown and became associated with the late Tom L. Johnson and A. J. Moxham of the Johnson Steel Rail Co., as manaager of the rolling mill. Here he made many improvements in the rolling of girder rails. In 1894 he was appointed general manager and placed in charge of the designing and building of the new plant at Lorain, Ohio. When this plant was taken over by the United States Steel Corporation, Mr. Suppes remained in charge and there he designed and built the blast furnace and ore receiving docks which were added to the works. He was a member of the American Iron and Steel Institute.

## SOCIETIES

**Mining and Metallurgical Society of America**—The next meeting of the New York Section will be held April 19 at the Engineers' Club, New York, for discussion of the revision of the mining laws. Unusually large attendance expected.

**Chemical Engineers**—The third annual meeting of the Chemical Engineers, with which was combined the March meeting of the Kansas City Section of the American Chemical Society, was held at the University of Kansas, Lawrence, Kan., Mar. 31, R. O. Neal presiding. Morning and afternoon sessions were held and a large number of papers read, among those interesting to metallurgists being one on flotation by George Belchic; on the present situation of zinc smelting by E. H. Burtch, of Iola, Kansas, and one on losses and problems in the Joplin district by C. A. Wright of the U. S. Bureau of Mines.

**Pennsylvania Safety Conference**—At the call of the state authorities a conference was held at Harrisburg, Penn., Mar. 23, to devise means for reducing industrial accidents, about 400 being present. Two sessions were held, at the first of which addresses were made by Governor Brumbaugh, John Price Jackson, State Commissioner of labor and industry, and Samuel Gompers of the American Federation of Labor. At the second session addresses were made by James T. McCleary of the American Iron and Steel Institute; Van H. Manning, director of the U. S. Bureau of Mines; C. L. Close of the United States Steel Corporation, and others. It was decided that committees to take up safety measures for the various industrial branches should be appointed by Commissioner John Price Jackson, such committees to hold meetings at Pittsburgh, Harrisburg or Philadelphia. The committee for the steel trade is composed of Quincy Bent, C. W. Heppenstall and William B. Dickson. For coal mining, of Robert A. Quinn, John B. Kerr and H. A. Taylor.

## INDUSTRIAL NEWS

The Ingersoll-Rand Co. reports $5,459,884 earnings for 1915, compared with $1,967,723 for year previous. Surplus at end of 1915 is $3,265,480 against $550,241 at end of 1914.

The Traylor Engineering and Manufacturing Co., of Allentown, Penn., has recently been awarded the contract by the Bunker Hill & Sullivan Mining and Concentrating Co. for three silver-lead blast furnaces 48 in. wide by 180 in. long at the tuyeres; having a smelting column of approximately 20 ft. 6 in. These furnaces are equipped with a double tier of jackets, the lower ones being provided with Traylor patented welded tuyeres.

The American International Corporation has undertaken the financing of sewerage and water-works in Uruguay. This is the first contract taken by the new $50,000,000 corporation formed to promote foreign trade by Frank A. Vanderlip, of the National City Bank of New York. The original contract was obtained by the Ulen Construction Co. of Chicago, and the actual work is to be done by that company, the American International Corporation doing the financing.

# Editorial Correspondence

### SAN FRANCISCO—Mar. 29

**Former President William S. Noyes,** of the Presidio Mining Co., recently arrested on complaint of Captain W. S. Overton, United States Army, and charged with embezzlement, lost his case in the Appellate Court wherein he sought by writ of habeas corpus to escape trial. The Appellate Court dismissed the writ and remanded Noyes into the custody of the Sheriff. Bail had been fixed in the sum of $1,000 bond or $500 cash. The Appellate Court yesterday found after a careful study of the record of the lower Court that sufficient evidence had been produced to warrant holding Noyes to answer on the charge to the Superior Court.

**The Launching of Yuba No. 15 Dredge in Yuba Basin Field,** on Sunday, Mar. 26, was accomplished without the slightest jar or disarrangement in any feature. The ways went into the water as smoothly as a toy boat in a placid lake. The method of launching differed from that in ordinary practice. The four skids extended a few feet beyond the bow of the boat. Two of the trips were attached on the sides of the outer skids about one-third of the length of the boat from the bow, the other two trips were attached to the skids about 10 ft. under and from the extreme end of the stern. Men were stationed at the trips and at the appointed time when signal was given the stulls were knocked out with hammers. Jack screws were installed on the center skids at the stern and only two trips of the two screws were necessary to give the boat a start. It went into the water so smoothly that the 150 people abroad were not aware that the dredge had floated until the 400 people on the shore had waved a greeting.

**There Are a Number of Old Mines on the Mother Lode** which have for many years remained idle but which were in early days, large producers of gold. Some of these old mines have been reopened during the past three years. There is probably no other district in the state in which so much practical development work is now progressing as in Amador County. About three years ago, the Keystone, a producer of many millions of dollars in early days, was reopened and for a long time wavered between the producing and the prospecting class of mines. But intelligent and persistent effort has brought the Keystone back to the producing class, and although there has been little said about it, its development and operation have been steady. A great deal has been said about the Plymouth Consolidated. This mine was reopened and developed for Berwick, Moreing & Co. and is now, and has been for the last year a steady and profitable producer. The Treasure mine has within the past two years been reopened and although for a period was in an unfavorable condition, is now being developed and will soon be put into the producing class. A number of small properties in Amador County have also been reopened in the past two years. But the most recent and interesting reopening of mines in this district is that of the old Eureka. This is the mine which was for a long time known as the Hetty Green mine and is now known as the Amador Consolidated. This property in the time of its ownership by Alvinza Hayward produced in the neighborhood of $10,000,000 and all this from above the 2,500-ft. level. The reopening of this property has just begun under the direction and management of practical mining men who have the means for thorough exploration and development.

### DENVER—Mar. 31

**The Primos Company Has Raised Its Schedule** of tungsten purchase prices from lessees. All leases expire July 1, but may be renewed for six months at a time. Effective Apr. 1, lessees will be paid $35 per unit on low-grade tungsten ores and $60 on high-grade, these figures supplanting existing prices of $23 and $35, respectively. Ground that was closed to prospectors on Mar. 1 has been thrown open for leases.

**Search for Tungsten Results in Reviving Activities** in a group of 15 claims patented years ago along the Florence and Cripple Creek R.R. about 15 mi. southeast of Victor. Although this group was filed upon for gold-mining purposes, sufficient tungsten was then recognized in the ore to warrant the owners in styling themselves the Wolframite Gold Mining and Milling Co. Molybdenite is also present in the ore. C. D. McHenry, of Martin's Ferry, Ohio, has secured a lease and begun mining, while miners from the Cripple Creek district are actively prospecting in the vicinity.

**The Fortune Mine, Leadville,** was scene of an unusual accident, Mar. 27, when two men were lowered in the cage for the purpose of repairing the broken bell-rope. A short distance below the 650 level, the descent of the cage was blocked. While one man secured safety on a set of shaft timbers, the other man, Angelo Travison, climbed onto the bonnet and jiggled the cable as a signal to the engineer to hoist. Mistaking the signal, the engineer continued paying out cable which piled up about Travison so rapidly he could not escape. Realizing his error, the engineer then reversed and began hoisting rapidly entangling Travison in such fashion that his left foot was severed. After some delay, he was released by miners of the 650 level and carried through old workings and down a chute into the Yak tunnel whence he was removed to a hospital.

**Cripple Creek District** furnishes the following interesting items for the past week: El Paso has introduced the split-check system, effective Apr. 1, but optional for acceptance by lessees. Vindicator expects to meet payment of its three remaining notes issued in payment for the Golden Cycle mine by Apr. 9, thus completing full payment of the $1,250,000 in just one year from the date of purchase. The Elkton company's new officers are E. P. Shove, president; A. E. Carlton, vice-president; T. W. Gauss, secretary-treasurer; H. M. Ragle, assistant secretary-treasurer; R. P. Windsor, superintendent. Yellow Bird has opened a 12-in. vein in its property on Gold Hill assaying gold, 18 oz.; silver, 26 oz.; zinc, 33%; lead, 3%—unique for Cripple Creek. Cripple Creek Central Ry. has elected the following new members on its board of directors: Spencer Penrose, president, J. A. Hayes and A. E. Carlton.

### SALT LAKE CITY—Mar. 31

**Park City Will Have Another Mill,** to be built by the Silver King Consolidated Mining Co. Machinery has been ordered, to be delivered in the next 45 days, and it is expected to start work on foundations soon. Concentration is to be used, although flotation may be added. An aërial tramway, 2 to 3 mi. long, will bring ore from the mine to the new mill and the railroad. This will cut out the bad haul around Rocky Point, where it is hard to keep the road open in the winter. Work is to be started on the proposed deep tunnel, which is to prospect and unwater the Thaynes Cañon section, as soon as the snow will permit.

**The Tintic Milling Co. at Silver City** has three Holt-Dern roasters in operation, treating about 150 tons of ore per day. Interest is being taken here in the working out of the process for treatment of low-grade ores of the Tintic district, which, if successful, will be of much importance to the camp. Options have been secured on a number of the large dumps. The new plant is designed to treat 300 tons per day working at capacity, so as to be able to handle both ore from the Knight properties and custom ore. To date the roasters have not been brought up to capacity.

**The Department of Metallurgical Research** of the School of Mines, University of Utah, has established five research fellowships in metallurgy, each having an annual value of $720. These fellowships are open to college graduates, who have had good training in chemistry and metallurgy. Applications should be made to Joseph F. Merrill, and will be received up to May 15, 1916. Applicants are required to send a copy of their records from the registrar's office of their college, and the names of at least three references, who know their character, ability and attainments. Fellows are appointed for one year, but the appointment may be renewed. Holders of fellowships for the coming year report for duty July 1. During the fiscal year 1915-1916, the following investigations have been undertaken: A study of the flotation processes in order to determine their applicability to the treatment of ores, which are not at present being treated by such processes and especially to the low-grade carbonate ores of Utah; the hydrometallurgical treatment of low-grade and complex lead ores; the treatment of carbonate ores of zinc especially with reference to the hydro-metallurgical and igneous concentration processes; a study of the effects of roasting on complex zinc-lead-iron-sulphide mixtures, with special reference to the solubility of the various constituents of the ore after roasting; electrolytic deposition of lead and zinc from their solutions; cyaniding of refractory silver ores with

especial reference to aluminum as a substitute for zinc in precipitating gold and silver from cyanide solutions; losses in milling processes. The work of the metallurgical research department is under the direction of metallurgists of the United States Bureau of Mines assigned to duty at the University and at Salt Lake City. The University believes that the fellowships offer a splendid opportunity to young men intending to enter the metallurgical profession to thoroughly familiarize themselves with uptodate metallurgical practice, especially in the treatment of non-ferrous ores, and to become proficient in the adaption of these processes along the lines of investigation carried on by them.

**LEADVILLE, COLO.—Mar. 31**

**Draining the Down-Town Basin Is Nearing Completion.** The water has been lowered to the 860-ft. mark with only 24 ft. remaining to be drained. Machinery equipment for the installation of a permanent pumping plant at the bottom level is arriving daily. Although no official date has been set for the completion of the enterprise, it has been conservatively estimated that it will require three weeks to reach the bottom. Obstacles in the shaft have retarded progress to some extent and the shaft has to be carefully sounded before lowering the sinking pump. The plant is now operating without a hitch.

**Pumping Has Been Started at the Harvard Shaft** by the United States Smelting, Refining and Mining Co. The preliminary work of equipment and repairs, according to Manager H. S. Lee required just 44 days. The shaft is now one of the best equipped properties in the district. The machinery installed includes a double-drum electric hoist with a lifting capacity of 5,000 lb. at the rate of 400 ft. per min. set up in the new engine room. A large compressor has been purchased and will be installed when sinking is started. Underground a shaft station has been cut just above the old water level 250 ft. below the collar. Here two electrically driven Krogh relief centrifugal pumps have been installed. They have a total capacity of about 1,000 gal. per min. The sinking will be done by a Krogh deep-well pump of similar design. This pump in the shaft station is on heavy steel supports fixed on cement foundations. The suction, or intake, pipe is 150 ft. long. The first water was pumped from the shaft on Sunday, Mar. 19; pumps threw about 1,500 gal. a min. Steady draining started Monday, Mar. 20, and during the first 8 hr. the water was lowered 9 ft. Progress has now settled down to the rate of 4 ft. a day. The shaft is 407 ft. deep and Manager Lee states that he expects to have the property drained within 90 days.

**MORENCI, ARIZ.—Mar. 31**

**The Arizona State Federation of Labor Promises** a full program at the coming election. Among the proposed measures are the following: A bill creating a state department of labor, the head of which shall receive a salary of $3,000 and unlimited traveling expenses. One of the duties of the commissioner shall be to act as chairman of a board of arbitration to settle all industrial disputes. The employer shall select one arbitrator and the employees one. One proposed amendment requires the legislature to enact a workmen's compulsory compensation law that is absolutely compulsory, not giving the injured workman the privilege of compromising with his employer. Another amendment will abolish the state senate.

**Phelps, Dodge & Co. Has Acquired** the Bennett-Stephenson, Torpedo, Memphis, Modock, Excelsior and other properties, situated in the Organ district, Dona Ana County, New Mexico. Some of the mines were purchased outright, some were bonded and leased, while options were taken on others. The properties extend for about 10 mi. north and south on the west side of the Organ Mountains. The total consideration is about $1,500,000, of which substantial initial payments have been made. This is the largest mining deal consummated in the southwest for some time, and it promises for the Organ country a camp similar to Morenci or Tyrone. The Bennett-Stephenson is the oldest, and greatest former producer of the properties, having produced over $2,000,000 in lead, silver, copper and wulfenite. A specimen of wulfenite which took the premium at the World's Fair at Chicago, now the property of the Smithsonian Institute, was taken from the Bennett-Stephenson in 1888. The Torpedo lies north of the Bennett-Stephenson and has a production record of $1,000,000. Some of the ore from the Torpedo averaged 13% copper. The Memphis lies north of the Torpedo and is also a copper proposition, but contains silver, gold and zinc as well. Within the last year, leasers have taken from the Memphis $40,000 worth of ore, running 10% copper, $3 gold and $3 silver. The Phelps-Dodge interests secured the first option in January, and since that time have had engineers on the ground making a detailed examination, taking an inventory and planning workings for future extensive development. E. Frazier-Campbell, for several years consulting engineer at Tyrone, will be in charge as manager of all the properties in the Organ district. There has been much litigation and disagreement among the owners and operators of the Organ properties in the past, which precluded extensive systematic development and which made the recent consolidation difficult to accomplish. To J. I. McCullough is given the credit of clearing away the litigation, harmonizing differences, and bringing about the big deal. Mr. McCullough has been interested in the Organ district for the past 12 years and has worked incessantly for the last 18 months to effect the deal. A railroad built from Las Cruces to the properties in the near future is regarded as being highly probable.

**DULUTH, MINN.—Apr. 1**

**Everything Is Ready on the Mesabi Range** for the opening of the 1916 season just as soon as navigation opens. An official of the U. S. Steel Corporation has stated that the corporation would produce 25% more ore from the Mesabi and Vermilion Ranges this year than in any previous year. The anticipated production of 55,000,000 tons means an average daily shipment of 350,000 tons, of which probably 250,000 tons will go through Duluth-Superior harbor. The ice in the harbor at present is 34 in. thick, but is beginning to show signs of breaking. On Lake Superior, the field of ice is unbroken for a distance of 15 mi. from shore. It is not anticipated that navigation will open much before May 1, although shipments from mines to dock will begin not later than Apr. 15.

**JOPLIN, MO.—Apr. 1**

**The United States Smelting Co.** continues to make steady production from the old Ravenswood mine at Reeds, Mo. The March output totaled 333,000 lb. of blende.

**The Aurora Zinc Mines Co.** recently took a lease on 160 acres of silicate land that has not been mined for 20 years, which lies immediately east of Aurora. Pumps will be installed immediately and the tract opened up for mining. When it was formerly mined, silicate was bringing only from $12 to $15. This week as high as $87 was paid for no better ore.

**The Picher Lead Co.** has started construction on a 3,200-retort zinc smeltery at Henryetta, Okla., and expects to have it ready for operation by Aug. 1. It will use gas for fuel and will cost, according to O. S. Picher, president of the company, between $225,000 and $250,000. The company already is operating the zinc smeltery formerly owned by the Collinsville Zinc Co., at Collinsville, Ill. Extensive improvements also are being made to the Galena, Kan., lead smeltery, owned by the Picher Lead Co. Eight new Jumbo retorts are being installed and the plant, when improvements are complete, will have a very large capacity. The Picher Co. is pushing mining operations in the north Oklahoma field. It has two concentrating plants now going and a third will be ready for starting in 30 days. Still a fourth has just been begun which will have a capacity of 600 tons per shift and will be one of the largest mills in this district.

**OTTAWA—Mar. 27**

**The Report of the Prohibition of the Export of Nickel** by an order-in-council by the Canadian Government has been so variously garbled by the daily press that the following statement by Sir Robert Borden, in reply to a question asked by Sir Wilfrid Laurier is worth perusing. "The reason for the passage of the order-in-council is that a small quantity of nickel has very recently been sent to the United States by a small company, with which the Government had no arrangement. Neither the Canadian nor the British Government was in a position to trace the destination of that nickel without a good deal of difficulty. Therefore, it is proposed to prohibit the export of nickel, but to continue the exportation under license from time to time, which will make it necessary for any person or corporation exporting nickel from Canada to the United States to enter into arrangements as satisfactory as those which were consummated in the early months of the war with the International Nickel Co."

**TORONTO, ONT.—Apr. 3**

**Interest in the Porcupine Gold District** is aroused by the entrance into that field of the two prominent Cobalt companies, the Coniagas and La Rose. Each of these companies has, up to the present, examined and refused many prospects, but recently Clifford E. C. Smith, examining engineer for the Coniagas company, recommended for exploration and secured under option the group of claims owned by the Ankerite Mining Co. About the same time G. C. Bateman, field engineer for the La Rose company, recommended prospecting work on the Maidens-McDonald group. These two groups situated in Deloro Township, adjoin and are on the same vein system about 1 mi. southwest of the Dome mines and 2 mi. southeast of the Hollinger and Acme property. It is now felt in Porcupine that this interesting area in Deloro will receive merited attention.

# The Mining News

## ARIZONA

### Cochise County

TWO PEAKS (Huachuca)—New air compressor being installed; three shifts will soon be put on proposed 4,500-ft. tunnel, now in 40 ft.; 200-ft. tunnel on Buck claim in 2% copper ore total length.

MASCOT COPPER (Mascot)—Two new strikes reported: Entire face of No. 3 drift on 150-ft. level in ore; second strike made on 200-ft. level. Power plant, recently damaged by fire, repaired and furnishing air for drills.

### Gila County

COMMERCIAL (Copper Basin)—Shipping 100 tons daily.

ARIZONA PORTLAND (Copper Basin)—Churn drills being installed.

IRON CAP (Copper Hill)—February production 237,870 lb. copper, costing 10.44c. per lb. Average price received, 26.64c., profits $38,520.

SUPERIOR & BOSTON (Globe)—Main shaft now 1,200 ft. deep, will be sunk several hundred feet deeper, in hope of striking higher-grade sulphides than now exposed. Work will be financed by assessment of $1 a share, payable by outstanding issue of 283,827 shares.

ASH CREEK ASBESTOS (Globe)—Clean asbestos fiber being shipped to Philadelphia from Globe at rate of 40 tons a month. Brought from Ash Creek mine to Globe, where it is cleared of gangue by simple mill, invented by Superintendent Edward Torrey. Mill capacity is to be trebled; product rated superior to Canadian.

MIAMI, INSPIRATION AND OLD DOMINION shipped 49 carloads of copper bullion, valued at $1,063,870, in single consignment to New Jersey refineries. Shipment represents week's output of Miami and Inspiration, together with 9 cars from Old Dominion. Previous scarcity of rolling stock reason for so large single shipment.

INSPIRATION (Miami)—Material for 19th and 20th units of mill being hauled to site; present capacity for 15,000 tons will be increased by 1,700 tons daily. According to H. Kenyon Burch, present mill contains only three pieces of machinery originally in contemplation, viz., the electric cranes. While original plans were for 7,500-ton mill to cover eight acres adoption of oil-flotation process has permitted doubling originally planned capacity within space of three acres. March production was 9,300,000 lb. copper, an increase of nearly 1,000,000 lb. over February.

### Mohave County

OATMAN GOLD M. & M. (Oatman)—Crosscuts at 500-ft. level driven 30 ft. both ways.

WESTERN ARIZONA R.R. (Kingman)—Compelled to put on extra daily train to handle increased ore output.

GOLD ORE (Oatman)—Shipping 20 tons daily to Gold Road mill. Reported 30,000 tons blocked out, assaying $11.20.

DIAMOND JOE (Cedar)—Francis E. Wilkinson, associated with J. M. Wright, both of San Francisco, will reopen and develop.

NEEDLES MINING AND SMELTING (Chloride)—Has taken over Pinkham and Comanche properties, and work on large scale now expected. Large orebody said to have been recently opened in Comanche.

BIG JIM (Oatman)—To provide for further development and full equipment, company has concluded sale of 200,000 shares of treasury stock for $350,000. Announcement regarding identity of purchasing syndicate not made public.

WRIGLEY EXPLORATION (Oatman)—Syndicate has taken over 11 claims of Beck and Wright in Black Range district; purchase price approximately $150,000; O. H. James, consulting engineer. Property crossed by four main veins and several smaller ones; development will begin at once.

### Pinal County

NEWBURY (Superior)—Purchased by A. W. Scott at sheriff's sale; price, $1,800 and cost; sale made to satisfy $1,620 judgment given to R. C. Scofield.

### Pima County

MINERAL HILL (Tucson)—Plans increasing daily output from 100 to 200 tons. More machinery will be installed.

### Yavapai County

VERDE EXTENSION (Jerome)—Little Daisy shipping 200 tons high-grade daily; operations on 1,100-ft., 1,200-ft. and 1,400-ft. levels being pushed.

UNION (Chaparal)—Engineers have concluded examination for Eastern investors. John S. Jones, owner, shipping ore averaging $200 a ton, concentrating ore running $36 to $40.

CONSOLIDATED ARIZONA SMELTING (Humboldt)—Increased production at De Soto and Bluebell mines necessitates increased smelting capacity. Machinery ordered for increasing flotation section from 250 to 600 tons daily. Mines supplying smeltery with 10 cars a day.

### Yuma County

J. H. ROBINSON, secretary of Arizona Chapter American Mining Congress, has invited all owners of producing mines in Arizona to meet Tax Commissioners in joint conference at Phœnix. Among questions to be discussed is that relating to rendering of reports by operators to the commission.

## CALIFORNIA

### Amador County

ONEIDA (Sutter Creek)—Reported that while unwatering mine, drifting on levels above water disclosed good ore.

ARGONAUT (Jackson)—New 5,000-ft. Roebling hoist cable, of plow steel, being installed. Construction work on new Eastwood dam will be finished about May 15.

### Calaveras County

UTICA (Angels Camp)—Gold Cliff development has reached point where connection with Utica is expected on 2,700-ft. level. Gold Cliff large vein developed to 1,900-ft. depth proved vein extends south. Gold Cliff mill crushing 6,000 tons per month with 20 stamps.

### Nevada County

QUEEN REGENT MERGER (Spenceville)—Is developing copper property. Smeltery of 15 tons daily capacity erected to treat own ore and secure funds for development. Local interest in surrounding territory recently stimulated by results.

BRUNSWICK (Grass Valley)—Preparing to sink shaft 300 ft. below 1,000 ft. point. Development in main levels continues favorably, showing some high-grade ore. About 16,000 tons of ore blocked out; 40 stamps crushing 3,000 tons per month, averaging about $10 per ton.

### Sacramento County

NATOMAS (Natoma)—According to press reports, company realized from its gold-dredging operations profits of 5.255c. per cu.yd. in 1915, or $1,313,800 net profit from the washing of about 25,000,000 cu.yd. The reserves of gravel at end of 1915 amounted to 206,000,000 cu.yd., about eight years' supply at present rate of dredging.

### Shasta County

AFTERTHOUGHT (Ingot)—Reported negotiating for sale of property to Eastern men. If deal is made a smelting plant may be installed.

GREENHORN (Copper City)—Shipping ore to Mammoth smeltery. Reported that company contemplates installation of metallurgical plant.

### Siskiyou County

RED HILL (Etna)—Property owned by Michigan Mining Co. operating three large elevators and five giants. Plentiful supply of water will probably last until end of July.

### Tuolumne County

DUTCH-SWEENEY (Jamestown)—Improvement in the metallurgical plant continues. Drift recently cut on 1,600 level producing good ore.

RAWHIDE (Jamestown)—New Cameron pump being installed, with capacity of 400 gal. per min. raising to height of 500 ft. John Mocine, superintendent.

### Trinity County

GOLDEN JUBILEE (Carville)—Work resumed with 30 men, the number to be increased as necessary. New metallurgical plant will be installed.

TRINITY DEVELOPMENT (Carville)—Preparations being made for installation of a 9-cu.ft. bucket-elevator dredge on Coffee Creek. Dredge built by Marion Steam Shovel Co. and machinery is on the way. Company controls 12 mi. of territory along Trinity River prospected with Keystone drills.

### Yuba County

PACIFIC DREDGING (Marysville)—Preparing for installation of 9-cu.ft. bucket-elevator dredge on Yuba River between Hammonton and Smartsville. Electric transmission line being installed in advance of construction work on dredge whose machinery is being shipped by Marion Steam Shovel Co.

## COLORADO

### Lake County

DENVER MINING AND MILLING (Leadville)—Old Alicante, later known as John Reed property, being reopened by this company. Old 500-ft. tunnel being retimbered; mill being remodeled into flotation plant for concentrating lead-zinc ore, of too low grade for profit under former price conditions. Property will be operated on large scale. E. E. Miller, manager, and O. H. Kold, superintendent, both of Denver.

### Ouray County

CAMP BIRD (Ouray)—Ore treated during February, 2,330 tons; estimated profit, £7,500.

### Summit County

DREDGING OPERATIONS in Breckenridge district started recently by French Gulch dredge. Three dredges of Tonopah company undergoing repairs but will be in operation soon. Water supply already good, and increasing daily.

DREADNOUGHT (Breckenridge)—Developing in tunnel where ore of good grade reported opened.

OLD UNION (Breckenridge)—Work on new shaft temporarily suspended on account of unusual inflow of water. Large force is operating through tunnel.

JUMBO (Montezuma)—Property now being operated by the Philadelphia Mines Co. Five teams hauling ore to Toledo mill. Number of employees will be increased soon as roads permit ore shipment.

WILSON (Kokomo)—Milling plant being remodeled into flotation plant will treat ore from mine, now under lease to Leadville and California men. Campaign of extensive development will be started soon.

SILVER WAVE (Montezuma)—Force of 15 miners now at work. Ore hauled to Silver King mill. About 15 tons concentrates hauled daily to railroad at Keystone from Silver King and Toledo mills.

**Teller County**

SUMMIT (Cripple Creek)—Being developed under lease by Kenner, Portis & Co. A shoot of $30 ore opened at depth of 250 ft.

COLORADO KING (Cripple Creek)—Reopened by Wetherald & King, lessees, who have developed body of milling ore and are shipping product to Portland mill.

DILLON (Victor)—New equipment ordered for shaft, foundations laid, and machinery will be installed upon arrival soon. J. D. McCarthy is superintendent.

VINDICATOR (Independence)—Ready Money vein cut recently at 2,025-ft. level and satisfactory assays obtained. Further development on this vein will be undertaken. H. P. Nagle is superintendent.

ISABELLA (Cripple Creek)—Rich strike made on Buena Vista vein. Oreshoot opened 20 ft. at bottom level of Lee shaft, at 1,300 ft. depth; ore is 3 to 3½ ft. wide and samples assay 6 oz. gold a ton. Development work at bottom of Lee shaft is done on company account under direction of C. G. Mitchell, superintendent.

GOLD SOVEREIGN (Cripple Creek)—W. A. Reed has secured long-time lease on dumps and will treat ore in new cyanide plant of 100 tons' daily capacity to be erected on site of old Gaylord mill. Plans are in preparation, and machinery will be ordered in near future. Ground already broken and new plant planned for operation by June 1.

BUCKEYE MINES AND MILLING CO. (Cripple Creek)—New company capitalized for $50,000 by E. S. Johnson, W. J. Chinn and Robert C. Argo, of Colorado Springs; Cleveland capitalists are interested. E. S. Johnson is one of chief owners of Blue Bird mine, on Bull Hill, and new organization plans to erect mill on or near Blue Bird property to treat Blue Bird dumps and large bodies of milling ore in mine.

**ILLINOIS-IOWA**

LITTLE CORPORAL (Galena, Ill.)—A 50-ton mill is under construction. Shaft is sunk. Recent drillings showed good jack.

CLEVELAND (Dubuque, Ia.)—Dinsdale property, formerly operated by Appleton-Galena Co., has been taken over and operated.

**MICHIGAN**

**Copper**

ALGOMAH (Lake Mine)—Shaft down 600 ft.

BALTIC (Baltic)—Fair rock showing up in bottom No. 3 shaft, now down to 31st level.

BOHEMIA (Lake Mine)—Resumption of diamond-drilling campaign planned for summer.

HANCOCK CON. (Hancock)—Has encountered unusually heavy solid mass native copper in working No. 7 opening.

ISLE ROYAL (Houghton)—Mill now running full capacity handling 55,000 to 60,000 tons per month with three units.

FRANKLIN (Demmon)—Crosscut from Pewabic now driven over 4,500 ft. has cut Kearsarge lode. Amygdaloid well charged with heavy stamp copper.

OSCEOLA CON. (Osceola)—South Kearsarge branch handling about 25,000 tons rock monthly, averaging about 17 lb. copper per ton. Total copper production for March reported close to 2,000,000 lb.

MAYFLOWER (Calumet)—Diamond drill hole No. 41 discontinued at depth of over 2,500 ft. after disclosing encouraging formation. New hole started 600 ft. north of No. 41. About $60,000 cash on hand with which to continue drilling.

TAMARACK (Calumet)—Extending three openings, the 20, 23 and 24, on Osceola lode from No. 2 shaft. Copper content of rock about as good as that of same lode on Calumet & Hecla. White Pine Extension shaft is now down 30 ft. Diamond-drilling results continue good.

**MINNESOTA**

**Cuyuna Range**

IRON MOUNTAIN (Manganese)—Reported that Duluth parties will exercise option for purchase of this lease. Eastern capital said to be interested. Product is manganiferous iron ore.

CUYUNA-SULTANA (Ironton)—From 200 to 300 tons of manganiferous iron ore being shipped daily via all-rail route to Eastern consumers. Property being operated at full capacity.

MACE (Nashwauk)—Two revolving steam shovels, Marion type 36, have arrived for use by Butler Brothers. The 315-ton shovel formerly in use here being moved to Quinn-Harrison pit for use on stripping soon.

**MONTANA**

**Beaverhead County**

AJAX MINE—Syndicate of Pittsburgh capitalists negotiating with Miller & Hanson for mine situated between Melrose and Rochester. Mine formerly one of big silver-lead producers of county. New equipment will be installed, water pumped out and shaft and tunnels retimbered. Operation expected by coming summer.

**Lewis and Clark County**

CAPITAL EXPLORATION CO.—Articles of incorporation filed in Helena by company consisting of Butte men, capitalized at $40,000. Will take over Blue Bell and 80 acres of adjoining ground in Scratch Gravel district and begin operations immediately.

YELLOW BOY (Helena)—Helena Mining Bureau putting property in shape for operation. Shaft retimbered and station being cut at collar of winze near shaft, preparatory to sinking on lead. Stoping in oxide zone; ore shipments to the company's mill, nearby, will be started soon.

**Powell County**

EMMA DARLING (Deer Lodge)—Operators M. H. Newman, Peter and Frank Vannier, of Deer Lodge, have shipped carload ore to East Helena smeltery.

**Silver Bow County**

ANACONDA (Butte)—March production was 26,600,000 lb. copper.

CORBIN-COPPER (Butte)—Judgment for $1,200 secured against company for damages done to adjoining property through operations of Gambrinus mine in residence section of Butte.

BUTTE & GREAT FALLS (Great Falls)—Meeting of stockholders will be held May 24 to vote on resolution to increase capitalization from 500,000 shares to 1,000,000 shares of par value $1.

BUTTE & LONDON (Butte)—Shaft down 1,450 ft., leaving 150 ft. yet to sink to point where cross-cutting is to begin. Estimated that shaft will be completed and station at 1,600-ft. level cut by June 1. At present 50 men employed.

TUOLUMNE (Butte)—Special meeting of stockholders will be held May 10 to consider sale of mine, increase capitalization and purchase other properties. Understood that company has offer from Anaconda of $250,000, which is considered too small.

BUTTE & SUPERIOR (Butte)—Company has purchased from General Charles S. Warren the Mastodon claim located north of Colonel Sellars claim of Butte & New York, controlled by Butte & Superior. It also has an option on Rising Sun claim, owned largely by W. F. Coban.

BUTTE & BACORN (Butte)—Prominent stockholders express hope that proposed reorganization can be effected within next three months. Efforts being made to interest new capital. Between $275,000 and $300,000 required to pay off $50,000 of notes for which mortgage was given on property, and to furnish funds for development.

BUTTE-DULUTH (Butte)—Creditors of company, who have been holding off to give chance to raise funds, have become discouraged and have petitioned court to direct Receiver Everett to sell all property of company and pay indebtedness. About $52,000 in wage and trades claims outstanding against company in Butte. There is also a bonded debt of $500,000, of which $400,000 is outstanding. Court has petition under advisement.

**Teton County**

MONTANA-CANADIAN OIL CO.—Dr. Witherspoon of Butte, president of company operating in Sweet Grass district of northern Montana, reports gas well with a flow of 12,000,000 cu.ft. of gas per day capped and under control. Company now making arrangements to market the gas.

**NEVADA**

**Esmeralda County**

SPEARHEAD (Goldfield)—At recent stockholders' meeting held in Goldfield, decided to reorganize on assessable basis. Shaft now down 630 ft. is being continued to cut latite-shale contact.

SANDSTORM-KENDALL (Goldfield)—Development of lower levels temporarily abandoned. Exploring rhyolite-andesite contact on 350-ft. level along which rich stopes of early days were discovered.

SILVER PICK CON. (Goldfield)—New Davis-Calyx core-drill, to cut a 5-in. core set up on 700-ft. level where it will be used for prospecting to a depth of about 1,200 ft. On 500-ft. level ore of milling grade being saved from Phelan vein.

GOLDFIELD CON. (Goldfield)—Total February production was 30,080 tons, net realization $60,315. Development work done was 3,151 ft., costing $4.87 per ft. Total net cost per ton, $5.14. Leasers shipped 680 tons, netting company $722.

**Humboldt County**

MONTEZUMA HILLS (Seven Troughs)—Three shifts retimbering Hays shaft which will be deepened to encounter Regan vein. Property adjoins Coalition.

**Nye County**

TONOPAH ORE PRODUCTION for week ended Mar. 25 was 8,544 tons valued at $179,052 compared with 8,771 tons for week previous. Producers were: Tonopah Belmont, 2,996 tons; Tonopah Mining, 1,850; Tonopah Extension, 1,800; Jim Butler, 750; West End, 526; Rescue-Eula, 138; MacNamara, 55; Cash Boy, 51; miscellaneous leases, 378 tons.

TONOPAH EXTENSION (Tonopah)—Net profit for February was $60,523. During month 7,085 tons produced having net value of $131,531. Bullion produced amounted to 1,678 oz. gold and 175,940 oz. silver. Company again reports oreshoot in Murray vein on 1,540-ft level, has a 30-ft. width of ore at distance of 100 ft. from previous crosscuts.

ROUND MOUNTAIN (Round Mountain)—Has acquired the extensive interests of Round Mountain Power and Water Co. comprising placer leases, water-rights, pipe lines, and also mining interests of David S. Llewellyn. Gives company control of practically all water tributary to Round Mountain.

NEVADA CHEMICAL CO. (Tonopah)—Company organized by Victor Barndt of Tonopah to take over development of potash-alum property near Silver Peak. In event of the application of Federal leasing system to Searles Lake, Calif., for which Mr. Barndt has been working, this company will apply for one of leases and $240,000 of capital stock has already been assigned to this account. Shareholders in old Railroad Valley Co., which prospected Nevada for potash under Mr. Barndt's direction, will be given an opportunity to participate in new enterprise in recognition of equities arising from past efforts in this direction.

**Storey County**

ANDES (Virginia)—Saved 22 cars of ore from intermediate and 350 level stope.

ALPHA AND EXCHEQUER (Virginia)—Joint north drift at 50-ft. point in quartz.

UNION (Virginia)—Shaft reopened and repaired to 285-ft. point below 2,000 level.

SIERRA NEVADA (Virginia)—Extracted 67 tons averaging $12 from No. 1 stope 2,500 level; started west crosscut from winze below 2,500-ft. level.

MEXICAN (Virginia)—Crosscuts on 2,500 and 2,700 levels in porphyry and quartz of low assay. Mill crushed 428 tons custom ore, averaging $17.74 per ton.

OPHIR AND CON. VIRGINIA (Virginia)—Joint west crosscut on 2,700 level extended to 475-ft. point in porphyry formation. No ore extracted during the week from Ophir on account of water.

UNION CON. (Virginia)—Extracted 361 tons, gross value about $7,000. From No. 4 stope, 74 tons averaging $25; No. 5 stope, 106 tons, $14.90; No. 1 stope, 180 tons, $17.42. Repairing 2,700 level continued.

CROWN POINT-BELCHER (Gold Hill)—Extracted from No. 3 stope 1,600 level, 469 cars; from No. 2 north drift, 16 cars; from No. 1 north drift, 1 car. Jacket mill received 210 tons mine ore and 597 tons dump rock. Shipped one bar bullion.

## NEW MEXICO

### Otero County

BOSTON & BRICE (Brice)—Company organized with capital of $2,000,000. W. W. C. Spencer, of Boston, John Colthor, of Orogrande, and Geo. E. Mofett and J. H. Denny, of Alamogordo, incorporators.

### Grant County

ECLIPSE (Steeplerock)—Is being unwatered; Geo. A. Kalar, president and manager.

CHINO COPPER (Hurley)—Reported considering erection of second flotation plant to treat tailings estimated at 4,500,000 tons; among new installations are two water-cooling towers, 20 ft. in diameter and 80 ft. high; concrete foundation for new concentrate bin completed.

## UTAH

### Beaver County

BEAVER RIVER POWER CO. has extended lines into mining territory and during recent months many mines have been using electric power or have signed contracts for its use, including Moscow, Cedar-Talisman, Leonora, Hoosier Boy, Old Hickory, Harrington-Hickory, Paloma and Croff. Transmission line is to be built soon by power company to serve Marysvale potash district in Piute County.

MOSCOW (Milford)—Car of copper ore shipped by this silver-lead producer.

FORTUNA-GOLD QUEEN (Beaver City)—Ore reported cut in south drift on property at Fortuna.

SHEEP ROCK (Beaver City)—Company's mill on North Creek has begun treatment of ore from the Davis-Hodges-McGarry lease at Fortuna. B. M. Westman in charge.

### Juab County

TINTIC SHIPMENTS for week ended Mar. 22 amounted to 141 cars by 18 shippers.

BLACK JACK (Silver City)—Developing at 800-ft. depth from the Dragon Consolidated. Assessment will be levied to push development work.

BECK TUNNEL (Eureka)—Low-grade ore opened on 1,100-ft. level, and showing considered encouraging. Forty men working at leases on this property and on Colorado adjoining.

EAST TINTIC DEVELOPMENT (Eureka)—Eleven cars zinc ore marketed by S. H. Buckley, operating under lease. Ore carries from 22 to 28% zinc, and comes in part from dumps.

DRAGON CON. (Silver City)—About 80 tons daily of low-grade being shipped to Tintic Milling Co. Silver-copper-gold ore of higher grade being mined from north end of property. Some iron ore being mined.

IRON BLOSSOM (Silver City)—Contract for 2,000 ft. of drifting to connect recently opened copper orebody with the No. 1 workings given to Walter Fitch, Jr., who furnishes all equipment. Mr. Fitch is doing contract work in Chief Consolidated and other properties. This method allows mining companies to give entire attention to extraction of ore, prospecting being done under contract. Drifts recently driven by Mr. Fitch averaged 5.8 ft. per shift.

### Salt Lake County

THE COUNTY COMMISSIONERS have approved of a formal agreement binding Salt Lake County, Salt Lake City, Cardiff Mining Co., and Boston Development Co., operating Maxfield mine, to spend $30,000 on improvement of road in Big Cottonwood Cañon. Terms of agreement are that county will spend $12,500, the city $7,500, and each of the mining companies $5,000, county to maintain road once put in such shape as will permit use of tractors instead of horses for ore hauling. Mining companies are bound to use tractors as long as road is kept in condition for them.

SOUTH HECLA (Alta)—Ten ore teams began hauling ore recently and they are expected to haul at a rate of 35 tons a day.

### Summit County

PARK CITY SHIPMENTS for week ended Mar. 24 amounted to 1,184 tons of ore and concentrates, the shippers being Silver King Coalition, Daly-Judge, Ontario and Silver King Consolidated.

DALY-JUDGE (Park City)—New electric hoist and compressor at mine are almost ready for operation.

ONTARIO (Park City)—Shipments for week ended Mar. 24 were 245,750 lb. Property again being worked on company account. Large bodies of ore left on lower levels following inundation several years ago are to be exploited.

BROADWATER MILLS (Park City)—Operating new 600-ton concentrator on characteristic lead-iron-zinc ores of district. Metallurgy said to be difficult due to percentage of oxidized ore occurring with sulphides. Gravity concentration and flotation being used. Mill capacity will be increased in near future. M. H. Kuryla is vice-president and general manager.

BIG FOUR EXPLORATION (Park City)—Stock of this company, owning property in Park City, Ophir, New Mexico, Idaho and Texas has been listed on the Salt Lake Stock and Mining Exchange. Property consists of 1,400 acres, of which 835 acres are patented. Company owns mining and milling machinery valued at $90,000. Has 60 men working, and shipments have amounted to about 45,000 tons, net returns approximately $485,000. There are 500,000 shares of stock, par value $1, with 100,000 shares and $118,000 cash in treasury. Debts are $10,000, and bonds outstanding of $149,000. Morris P. Kirk, president, and John Pingree, secretary and treasurer.

## WISCONSIN

### Zinc-Lead District

M. & A. (Platteville)—Big Tom shaft on Billy Thomas land at Rewey has been unwatered. Ore revealed has decided company to start immediate construction of a 100-ton mill.

TIFFANY (Platteville)—Chicago company has taken over John Plummer property at Potosi and commenced mining.

WISCONSIN ZINC (Platteville)—A 100-ton mill is under construction at the C. A. Thompson mine and another one at the Longhorn, both at New Diggings; a 100-ton mill is nearing completion at the Birkbeck, at Days Siding. Central power plant is contemplated at Skinner roaster, New Diggings. The Jack of Diamonds property, at New Diggings, taken over and mining and milling resumed.

## CANADA

### Ontario

WEST DOME (Porcupine)—Contract let for 10,000 ft. diamond drilling.

DELANEY-MORRISON CLAIMS (Tashota)—Claims bought by American syndicate.

TOMMY BURNS (Porcupine)—Two shafts will be started at once. T. B. Pope in charge.

CROWN RESERVE (Cobalt)—Will install plant on McCrea claims under option in Boston Creek.

CHAMBERS-FERLAND (Cobalt)—Vein 2½ in. wide carrying 3,000 oz. per ton cut in winze at 425-ft. level.

CONIAGAS (Cobalt)—Building camp and installing plant on Ankerite property, recently optioned in Porcupine.

CHISHOLM CORPORATION (Porcupine)—Has an option on Jamieson claims in Robb Township, and has taken up two adjoining claims.

CROESUS (Matheson)—Has cut vein at 300 ft. and while not as rich as on upper levels, shows some phenomenally rich ore. Shaft being extended to the 400-ft. level.

BUFFALO (Cobalt)—Installing more tube mills to bring capacity of flotation plant up to 600 tons a day. Company has about 350,000 tons of tailings stacked and expects to make recovery of 90% on 5 to 6 oz. heads.

MILLER INDEPENDENCE (Boston Creek)—Vein opened up in three places showing much free gold and a telluride that is probably calaverite. Shaft being sunk to cut vein at 50 ft. Rich ore being sacked.

DOME (Porcupine)—Sampling of vein cross cut at 7th level shows a width of about 244 ft. of ore running over $5, while in some places assays are considerably higher. Excavations being made for new steel headframe which will be 125 ft. high.

McINTYRE (Porcupine)—New mill unit now in full operation. Orebody discovered at 700 ft. by diamond drilling has been cut and is stated to be up to expectations. Station on 1,000-ft. level of McIntyre Extension completed and crosscut to No. 5 shaft started.

NIPISSING (Cobalt)—Annual report shows production of 4,097,391 oz. having gross value of $2,222,256. Cost per ton of ore was $10.02 and the cost per oz. of silver produced was 19.06c. Net revenue was $1,441,428 and dividends paid amounted to $1,200,000. Average price received for silver was 50.06c. an ounce. Surplus stands at $1,786,260.

DOME EXTENSION (Porcupine)—Directors have agreed to option property to Dome until Oct. 15, 1917, Dome to give 46,000 of its shares in payment if transaction is completed. In meantime Dome will drift from No. 3 shaft on 850 level onto Dome Extension property along strike of present Dome orebody. Dome Extension will develop whatever ore exists on 200-ft. level.

## MEXICO

### Hidalgo

SANTA GERTRUDIS, LTD. (Pachuca)—Ore treated during February, 20,944 tons; estimated profit, $18,000.

## COLOMBIA

PLATINUM PRODUCTION in western Colombia is increasing. Largest single producer is the Anglo-Colombian Development Co., operating dredge with good results, both in gold and platinum. There are many independent producers and U. S. Vice Consul Modica of Cartagena reports their present output as between 1,500 and 2,000 oz. per month. In 1915, 11,120 oz. of platinum were shipped to the United States from Colombia.

NECHI (Zaragoza)—Dredge was shut down on Mar. 11 for repairs. Last cleanup, $25,413 from 27,562 cu.yd., dug in five days.

PATO (Zaragoza)—This 8½-cu.ft. bucket dredge, which has been laid up for general repairs since Jan. 31, began digging again on Mar. 11.

## ASIA

### Chosen

ORIENTAL CONSOLIDATED (Unsan)—Cabled report states March cleanup was $136,255; grade of ore milled above average.

## RUSSIA

LENSKOIE (Bodaibo)—Drilling results so favorable that erection of the first of a fleet of large dredges is contemplated on company's property in Siberia. C. W. Purington, of London, is consulting engineer to Lena Goldfields, Ltd., the British company which is the largest shareholder in the Lenskoie company.

# The Market Report

## Metal Markets

**NEW YORK—Apr. 5**

All of the metals were strong and active during the week, copper being the most spectacular feature. Some extraordinarily large business in this metal was consummated.

New York Metal Exchange officers, chosen Apr. 3, are: President, Edwin Groves; vice-president, Charles J. Marsh; treasurer, Charles S. Trench; members of the board of managers, H. W. Hendricks, Emil Baerwald, A. B. Hall, Erich Benjamin, L. Vogelstein, Julius Loeb, Edward W. Starke, B. Elkan; arbitration committee, J. H. Lang, J. P. Wilson, R. F. Pearson, Edwin J. Keane, C. M. Loeb.

## Copper, Tin, Lead and Zinc

**Copper**—On Thursday and Friday the market was very active, large transactions, both for foreign and domestic account being made by all of the principal producers and agencies. The bulk of the business was done at 27c. regular terms, equivalent to 26¾c. net cash, New York, and that price was in the main irrespective of time of delivery. There seemed to be manifest a desire on the part of the producers to keep the market at that figure.

This activity followed the consummation of very large business with France. That business which had been under negotiation for some time previous was consummated on Mar. 29. The quantity was about 95,000,000 lb., for delivery up to next fall. The business was shared by the two largest producers.

Since then there has been further large business both with domestic consumers and with France. British buyers have not been doing anything.

During the latter part of the week sales made by the producers were at 27c., r.t., for July and later deliveries, and about 27¼@27½c., r.t. for April, May and June. Higher prices have been reported, but they appear to be on special transactions such as business that the principal producers did not care to take, or business in which some special financial conditions were introduced as part of the consideration.

Copper for April delivery is now very scarce, but May-June copper is still available. However, the bulk of the business done during the last week was for July and beyond.

On Mar. 30 the New York, New Haven & Hartford R.R. lifted its embargo on shipments of copper and spelter, with the proviso, however, that consignees coöperate sufficiently with the railway to prevent unreasonable delay in unloading cars.

**Copper Sheets** are 34½c. per lb. for hot rolled and 35½c. for cold rolled. Usual extras charged and higher prices for small quantities. Copper wire is 29@29½c. per lb. at mill, for carload lots.

**Visible Stocks of Copper in Europe** Jan. 31: Great Britain, 2,128; France, 3,400; afloat from Chile, 1,750; afloat from Australia, 4,800; total, 12,078 gross tons or 27,054,720 lb. This is a decrease of 2,410 tons from the Mar. 15 report.

**Tin**—This market advanced again, but there was no special reason to account for it, and no special feature of interest to report. The supply of spot tin is so short all the time that a very little buying is sufficient to advance the market.

**Visible Stocks of Tin** on Mar. 31 were: United States, excluding Pacific ports, 7,950; London, 7,475; Banka and Billiton, 3,357; total, 18,782 gross tons, an increase of 2,271 tons during February.

**Lead**—On Mar. 30 the A. S. & R. Co. raised its price to 7½c. New York. Before the advance was announced producers had sold at 7¾c. in the St. Louis market. As soon as the action of the A. S. & R. Co. became known, producers found themselves able to get 8c. St. Louis, and the market there became firm at that price. The action of the A. S. & R. Co. excited a good deal of surprise, for the market had exhibited a softer tone during several days immediately preceding, and, moreover, the statement that was made by the A. S. & R. Co. on Mar. 21 was assumed, incorrectly, to mean that that company would make no further advance in price. The reason for the advance on Mar. 30 was, however, a perfectly valid one. Since then, the lead market has been uncertain and perplexing. Certain producers have reported the realization of fancy prices, while others have reported that no such opportunities came their way. On the other hand, there have been claims of lead sold at lower prices. It is certain that lead has been sold for forward delivery at considerably less than current prices. Thus, June lead was sold in New York at 7½c., and July-August is said to have been offered in St. Louis at 7¼c. The business done during the week, including specific sales and sales to be settled for at monthly averages, was rather large. Japan, which retired from the market for a week or so, reappeared as a buyer. Negotiations with regard to a large lot of lead that was wanted by another foreign country led to the circulation of rumors that created a general feeling of uncertainty.

DAILY PRICES OF METALS IN NEW YORK

| Mar. Apr. | Sterling Exchange | Silver, Cts. per Oz. | Copper | Tin | Lead | | Zinc |
|---|---|---|---|---|---|---|---|
| | | | Electrolytic, Cts. per Lb. | Spot, Cts. per Lb. | New York, Cts. per Lb. | St. Louis, Cts. per Lb. | St. Louis, Cts. per Lb. |
| 30 | 4.7638 | 60⅛ | 26⅛ @27 | 49 | 7.50 @8.00 | 7.75 @8.00 | 16.00 @17.00 |
| 31 | 4.7638 | 60⅛ | 26⅛ @27 | 49 | 7.50 @8.00 | 8.00 | 16.00 @17.00 |
| 1 | 4.7638 | 60⅛ | 26¼ @27 | 49 | 7.50 @8.00 | 8.00 | 16.00 @17.25 |
| 3 | 4.7644 | 61⅛ | 26¼ @27 | 50 | 7.50 @8.00 | 8.00 | 16.25 @17.50 |
| 4 | 4.7644 | 61⅛ | 26⅜ @27¼ | 51 | 7.50 @8.00 | 7.87½ @8.00 | 16.50 @17.75 |
| 5 | 4.7644 | 61⅛ | 26⅜ @27¼ | 52 | 7.50 @8.00 | 7.87½ @8.00 | 16.50 @17.75 |

The quotations herein are our appraisal of the average markets for copper, lead, spelter and tin based on wholesale contracts for the ordinary deliveries of the trade as made by producers and agencies; and represent, to the best of our judgment, the prevailing values of the metals, reduced to basis of New York, cash, except where St. Louis is given as the basing point. St. Louis and New York are normally quoted 0.17c. apart.

The quotations for electrolytic copper are for cakes, ingots and wirebars. Electrolytic copper is commonly sold at prices including delivery to the consumers and is subject to discounts, etc. The price quoted for copper on "regular terms" is the gross price including freight to the buyer's works and is subject to a discount for cash. The difference between the price delivered and the New York cash equivalent is at present about 0.25c. on domestic business. The price of electrolytic cathodes is 0.05 to 0.10c. below that of electrolytic. Quotations for lead represent wholesale transactions in the open market for good ordinary brands. Quotations for spelter are for ordinary Prime Western brands. Only the St. Louis price is herein quoted, St. Louis being the basing market. We quote the New York price at 17c. per 100 lb. above the St. Louis price.

Silver quotations are as reported by Handy & Harman and are in cents per troy ounce of fine silver.

Some current freight rates on metals per 100 lb. are: St. Louis-New York 17c.; St. Louis-Chicago, 6.3c.; St. Louis-Pittsburgh, 13.1c.

LONDON

| Mar.-Apr. | Silver | Copper | | | | Tin | | Lead | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Standard | | Electrolytic | | | | | | | |
| | | Spot | 3 Mos. | £ per Ton | Cts. per Lb. | Spot | 3 Mos. | £ per Ton | Cts. per Lb. | £ per Ton | Cts. per Lb. |
| 30 | 28 11/16 | 114 | 112 | 136 | 28.96 | 200 | 195 | 34⅛ | 7.43 | 95 | 20.22 |
| 31 | 28 11/16 | 116 | 113 | 136 | 28.96 | 199 | 193½ | 34⅛ | 7.43 | 96 | 20.43 |
| 1 | 29 | ..... | ..... | ..... | ..... | ..... | .... | ..... | ..... | .... | .... |
| 3 | 29⅛ | 115½ | 112 | 136 | 28.95 | 197½ | 192½ | 34⅛ | 7.37 | 93 | 19.80 |
| 4 | 29 7/16 | 116 | 113 | 136 | 28.95 | 197 | 192½ | 34¼ | 7.29 | 91 | 19.38 |
| 5 | 29⅛ | 117 | 113 | 136 | 28.95 | 199½ | 193½ | 32 | 6.81 | 92 | 19.59 |

The above table gives the closing quotations on London Metal Exchange, All prices are in pounds sterling per ton of 2240 lb., except silver which is in pence per troy ounce of sterling silver, 0.925 fine. Copper quotations are for standard copper, spot and three months, and for electrolytic, price for the latter being subject to 3 per cent. discount. For convenience in comparison of London prices. in pounds sterling per 2240 lb., with American prices in cents per pound the following approximate ratios are given, reckoning exchange at 4.80. £ 15 = 3.21c.; £20 = 4.29c.; £30 = 6.43c.; £40 = 8.57c.; £60 = 12.85c. Variations, £1 = 0.21⅜c.

**Spelter**—On Thursday there was a little revival of interest and the market stiffened to 17c. for April and 16c. for June. On Friday it was very dull, but prices were steady. Later a large business for April-June delivery was reported done in certain quarters, while other producers reported scarcely anything done, except for delivery during the third quarter of the year and business in brass special. However, the demand, such as it was, together with the sentimental effect of the strength of copper were sufficient to advance the price and hold it very firmly. In general, the attitude of the producers is very stiff, and having faith in the maintenance of the present level of prices, they are holding spelter until buyers come to them and pay their price, which buyers do when they have to. This accounts for the strength of the market without there being any general activity. The business that was done during the week for April-June spelter ranged from 16½@17c., advancing as the week moved on. Business for July-September spelter was done at around 15@15¼ cents.

The Societa di Monteponi has begun the construction of a zinc smeltery at Vado near Savona, Italy. At that place it will be able to obtain the gas from a large coking plant. The use of gas from such a source will be an innovation in the metallurgy of zinc. It is expected that spelter will be produced in 1917.

**Zinc Sheets** are in steady demand and large orders are pending. The base price is unchanged at $25 per 100 lb., f.o.b. Peru, Ill., less 8% discount.

## Other Metals

**NEW YORK—Apr. 5**

**Aluminum**—The market is quiet and unchanged, the current quotation remaining at 59@61c. per lb. for No. 1 ingots, New York.

**Antimony**—Business has been quiet and the market is slightly easier. Chinese and United States brands are quoted at 44@45c. per lb. for spot or early delivery. Futures are also easier, Chinese for April-May delivery being offered at 32½@33c. in bond.

**Nickel**—The market is quiet and unchanged, with a good business forward. Ordinary forms are 45@50c. per lb., according to size of order. Electrolytic nickel is 5c. higher.

**Quicksilver**—This metal is again easier on a quiet and rather dull market. New York quotations are $170 per flask for large lots; up to $180 for smaller orders. There are reports that these prices can be shaded, but no specific cases can be cited. San Francisco reports by telegraph $175 per flask on a dull market.

**Minor Metals**—Current quotations for **Bismuth** are $3.15@3.25 per lb., New York. The London price is 11s. per lb.—**Cadmium** is quoted at $1.50 per lb., New York—**Cobalt** is held at $1.25 per lb. New York.—**Magnesium** is quoted at $5.50 per lb. for 99% pure.—**Selenium** is from $3 per lb. for small lots up to $4.50@5 for retail quantities.

## Gold, Silver and Platinum

**Gold**—Last week $2,500,000 gold from Australia was received at San Francisco, to order of the Canadian Bank of Commerce.

In March there were considerable shipments of gold—about $8,000,000 in all—from San Francisco to China.

**Platinum**—The market is very quiet and almost dull. There is no demand from jewelers at present. Prices are rather easier and sales are reported from $83@88 per oz. for refined platinum.

Our Russian correspondent reports that part of the metal taken over by the government has been released for export, so that sales have been resumed, but on rather a small scale. Some of the released metal has been sold for export to England at 65,000 rubles per pood—$63.70 per oz.—for crude metal, 83% platinum. The price to be paid for the metal taken and now held by the government has not yet been settled.

**Silver** has maintained its price and has even advanced, closing at 29⅝d. in London. The influences sustaining the market have been the same as were noted last week, chiefly the demand from the Continent for coinage.

Silver stocks in Bombay are reported at 4,400 bars, a decrease of 300 bars from last week. Stocks in Shanghai at the close of February were 996 bars and 44,415,000 oz. sycee; an increase of 196 bars and a decrease of 3,885,000 oz. sycee in February.

The Banco Comercial y Agricola of Ecuador has been authorized by the government to have coined and imported silver coins to the total amount of 400,000 sucres, or $194,680 in U. S. currency.

In correcting an error in silver prices last week, another slipped in. The price of 57⅜c. for silver there given should have been for Mar. 20, not for Mar. 27, as printed.

## Zinc and Lead Ore Markets

**PLATTEVILLE, WIS.—Apr. 1**

The base price paid this week for 60% zinc ore was $106@110 per ton. The base price offered for 80% lead ore was $95 per ton. No sales of lead ore were reported.

SHIPMENTS, WEEK ENDED APR. 1

| | Zinc Ore, Lb. | Lead Ore, Lb. | Sulphur Ore, Lb. |
|---|---|---|---|
| Week | 3,774,000 | ..... | 1,292,400 |
| Year | 54,192,000 | 1,072,750 | 14,435,600 |

Shipped during week to separating plants, 3,588,000 lb. zinc ore.

**JOPLIN, MO.—Apr. 1**

Blende, high price, $117.30; per ton 60% zinc, premium ore, $115; medium, $112@105; lower grades, $100@95; calamine, per ton 40% zinc $87.50@80; average selling price, all grades of zinc, $108.28 per ton. Lead, high price, $102.50; per ton 80% metal contents, $102@98; average selling price, all grades of lead, $99.76 per ton.

SHIPMENTS WEEK ENDED APR. 1

| | Blende | Calamine | Lead | Value |
|---|---|---|---|---|
| Totals this week.. | 16,400,070 | 2,154,410 | 2,765,880 | $1,142,560 |
| Totals this year... | 173,656,270 | 16,129,350 | 30,315,760 | $11,510,200 |

Blende value, the week, $917,810; 13 weeks, $9,596,250.
Calamine value, the week, $86,830; 13 weeks, $597,270.
Lead value, the week, $137,920; 13 weeks, $1,316,680.

The American Spelter Co.'s plant at Pittsburg was taken over by the Lanyons today, and it is unlikely there will be soon again purchases of as low-grade "junk" by any purchasing agency as the Joplin Zinc Ore Co. bought the past two weeks, supposedly for the American Spelter Co. The blende market was notably stronger on medium grades. Calamine continues to command exceptionally strong prices for the highest grades, free of lead. An effort is making to add a new feature to the buying market, a reduction of $5 per ton for each 0.1% of lead in high-grade ore in excess of 0.2%. Molders and machinists are out on a strike today at all the foundry and machine shops, and as there is a shortage of hard iron castings it is feared that the strike will seriously interfere with outputting.

## Iron Trade Review

**NEW YORK—Apr. 5**

Moderation is beginning to be apparent in the iron and steel trades, and it looks as if the continued advance in prices would be checked. This does not mean any falling off in activity and the mills are assured of plenty of work during the current year. Buyers, however, are beginning to count the cost and to be cautious about commitments too far ahead at high prices. In other words some conservatism is taking the place of the excited feeling which has been the rule for the past three months.

President Wm. B. Schiller, of the National Tube Co., has given details of the steel plant it was recently stated in general terms would be built at Gary, Ind. The National Tube Co. will erect a complete plant to manufacture bessemer steel and finish into regular welded tubular goods, the plant comprising ore docks, four blast furnaces of 500 tons daily capacity each, two 12-ton bessemer converters, two 40-in. reversing blooming mills, four skelp mills, comprising two continuous, one universal and one sheared, five butt-weld and five lap-weld pipe furnaces, with galvanizing, coupling and job shops, a warehouse and other appurtenances. This will be the first bessemer-steel plant to be built in 10 years, but bessemer steel seems generally preferred to open-hearth in pipe manufacture.

The McClintic-Marshall Construction Co. has purchased the large manufacturing and fabricating plant of the Riter-Conley Manufacturing Co. at Lettsdale, near Pittsburgh.

The Baltimore Sheet and Tinplate Works, recently completed, has been sold to the Bethlehem Steel Co.

Exports from Baltimore for the week included 4,877 tons steel rails and 619,240 lb. rail fastenings to France, 412 tons steel scrap, 150 tons pig iron and 32 tons anchors and chain to Italy; 632,902 lb. black sheets, 230,611 lb. pipe, 559,926 lb. wire and 1,723,249 lb. structural steel to Buenos Aires.

**PITTSBURGH—Apr. 4**

A feature of the market situation of growing prominence is the fact that many mills will not sell finished steel at prices they suggest as nominally representing the market. Their asking prices are increasing without formal advances being announced. The change in policy represents doubtless a desire to avoid any obligation to accept orders, but suggests also a desire to smooth the way for the time when orders will be acceptable at lower prices.

The steel market is steadily getting into a position from which prices can be readjusted with much more ease than has been the case when a large volume of open contract business was on books. Contracts are being avoided in favor of specific sales. The buying is less for the more distant deliveries and while the mills speak of being well sold up to the end of the year they are still entering very considerable tonnages for second-half deliveries. The feeling is growing that a heavy demand for steel will outlast the duration of the war and very much less apprehension is felt now than a couple of months ago.

Steel prices continue to stiffen, but do not seem to be advancing at the rapid pace of February and March. Even if buying should be relatively limited at present prices the accumulation on books is so large as to promise full operation well into next year.

About three-quarters of a million tons of rails have been sold for 1917 delivery, and Chairman Gary of the Steel Corporation announces that the corporation subsidiaries will maintain the present price to the end of this month, for delivery not later than May, 1917, but will make no commitment beyond that time, thus suggesting that recent rumors of an impending advance in rails may prove correct.

**Pig Iron**—The market is strong, but has failed to respond to fears of a definite shortage later. Gaged by current transactions and inquiry the market is distinctly quieter than a fortnight ago. Struthers furnace, making basic iron and expected to blow out about May 1, went out last week on account of an accident. We quote: Bessemer, $21@21.50; basic, $18.50; No. 2 foundry and malleable, $18.50@19; forge, $18@18.50, f.o.b. Valley furnaces, 95c. higher, delivered Pittsburgh.

W. P. Snyder & Co. announce the average prices in March, based on actual tonnage transactions, at $20.8625 for bessemer, an increase of 64.89c., and $18.25 for basic, an increase of 26.6c. over February.

**Steel**—Offerings of steel are still confined to stray lots, quotations on regular mill delivery being almost unobtainable. It is claimed that thousands of tons could be sold if made available at prices regarded as nominally the market, about $45 for bessemer and $45@50 for openhearth, either billets or sheet bars. Rods are about $60, with high carbon at about $75, while forging billets are $65 and higher.

### FERROALLOYS

**Ferromanganese**—There is no established market on prompt ferromanganese, the last important transactions having been at about $400. There remains some contract material available at $175, chiefly for the first half of 1917.

E. J. Lavino & Co., of Philadelphia, have purchased Sheridan furnace of the Berkshire Iron Works, Sheridan, and will make 80% ferromanganese, using Brazilian ores. The same interests have a conversion arrangement under which Meily furnace at Lebanon, will be started up to make ferromanganese. E. G. Rust will have the management of the two furnaces.

Receipts at Baltimore for the week included 953 tons ferromanganese from Liverpool.

**Spiegeleisen** for second-half delivery is quoted $70 per ton at furnace; but as high as $90 per ton is reported paid for a lot for early delivery.

**Ferrosilicon** is quoted at $83@85 per ton at furnace, on contract deliveries. Some material for early delivery has sold at $95 per ton.

### FOREIGN IRON

**German Steel Production** for the year ended Dec. 31, 1915, is reported by the German Iron and Steel Union as follows, in metric tons.

| | Basic | Acid | Total |
|---|---|---|---|
| Converter | 6,528,146 | 165,290 | 6,693,436 |
| Open hearth | 5,376,931 | 243,111 | 5,620,042 |
| Direct castings | 501,449 | 193,026 | 694,475 |
| Crucible | ..... | 100,046 | 100,046 |
| Electric | ..... | 129,647 | 129,647 |
| Total | 12,406,526 | 831,120 | 13,237,646 |

The total shows decreases of 1,708,556 tons as compared with 1914; and of 5,721,173 tons as compared with 1913, which was the year of highest production.

**Pig Iron Production in Germany** in January is reported by the German Iron and Steel Union as follows, in metric tons: Foundry iron, 164,401; forge iron, 21,840; steel pig—including ferromanganese, ferrosilicon, spiegeleisen and all similar alloys, 191,354; bessemer pig, 16,875; Thomas (basic) pig, 682,576; total, 1,077,046 tons. This is 47,902 tons more than in December, and 202,913 tons more than in January, 1915; but 489,649 tons less than in January, 1914; that is, about two-thirds of the normal product.

### IRON ORE

In the Lake Superior region active preparations are being made for the opening of the shipping season, and there will be little delay in beginning shipments at an early date.

**Iron Ore Imports in Great Britain** two months ended Feb. 29 were 746,309 gross tons in 1915, and 930,242 in 1916; an increase of 183,933 tons.

### OTHER ORES

**Manganese Ore** imports in Great Britain, two months ended Feb. 29, were 64,777 gross tons in 1915, and 56,622 in 1916; decrease, 8,155 tons. In Middlesboro, Brazilian manganese ore is quoted at 97c. per unit for 50%; while Indian ore is 63@64c. per unit.

**Tungsten Ore**—Quoted at $85 per unit.

**Antimony Ore**—Ore for forward shipment fetches approximately $2.60 per unit.

**Pyrites**—Receipts at Baltimore for the week included 6,018 tons pyrites from Huelva, Spain.

**Molybdenite,** 85 to 90% $MoS_2$, is quoted at $1.40@1.45 per lb. By an unfortunate inadvertence we have recently quoted molybdenite at $1.40@1.45 per unit instead of per pound, as it should have been.

### COKE

Coke production of the Connellsville region for the week is reported by the "Courier" at 459,468 net tons; shipments, 456,337 tons. Shipments of Greensburg and Upper Connellsville districts, 55,700 tons.

The United States Steel Corporation will increase the by-product coke plant it is building at Clairton to 650 ovens.

Coal and coke shipments Pennsylvania R.R. lines east of Pittsburgh and Erie two months ended Feb. 29, in short tons:

| | 1915 | 1916 | Changes |
|---|---|---|---|
| Anthracite | 1.657,406 | 2,108,458 | I. 451,052 |
| Bituminous | 6,527,991 | 8,515,999 | I. 1,988,008 |
| Coke | 1,425,235 | 2,321,335 | I. 896,100 |
| Totals | 9,610,632 | 12,945,792 | I. 3,335,160 |

The total increase this year was 34.7%, the heaviest proportional gain being in coke.

**Connellsville**—With the end of winter and no danger of a suspension in the bituminous mining districts blast furnaces are showing that they had larger coke reserves than estimated, and several suspensions of shipments on contracts, for a week or two, have been ordered. Struthers furnace, which was taking 15,000 tons a month, has gone out. There are rather free offerings of spot furnace coke, with scarcely any inquiry. The market is softer but not definitely defined. Contracting for foundry coke for six months or twelve months from July 1 continues apace, probably two-thirds of the regular contract business being now under cover. We quote: Spot furnace, $2.75@3; contract, $2.50@3; spot foundry, $3.75; contract, $3.50, per net ton at ovens.

## Chemicals

### NEW YORK—Apr. 5

The general markets are firm and steady. Business in heavy chemicals is on a good scale.

**Arsenic**—Demand is good. Glass makers are taking a good deal. Prices are firm at $6.50 per 100 lb. for spot and early delivery.

**Copper Sulphate**—Demand is good and prices are firm at $21 per 100 lb. for large lots; $21.25@21.50 for smaller orders. There is still some inquiry for export.

**Nitrate of Soda**—According to the figures of the Chilean Nitrate Committee shipments to Europe during February amounted to 2,585,671 quintals, equivalent to 117,531 tons. Arrivals in Europe in February amounted to 109,310 tons. Imports in the United States in January were 90,534 gross tons, against 18,059 tons in January, 1915. The market is easier, $3.45 per 100 lb. being quoted for spot nitrate.

**Sulphur**—Demand is large and steady. Owing to high freight charges the price has been advanced to $29 per gross ton, New York delivery. There is some scarcity of spot, owing to railroad delays.

### PETROLEUM

The monthly report of the "Oil City Derrick" notes new wells completed in March as follows: Pennsylvania grade, 365; Lima-Indiana, 73; Central Ohio, 32; Kentucky, 38; Illinois, 119; Kansas, 285; Oklahoma-Arkansas, 737; Texas Panhandle, 50; North Louisiana, 57; Gulf Coast, 111; total, 1,867 wells with a total daily production of 152,020 bbl. There were 145 gas wells and 339 dry holes. On Mar. 31 there were 3,269 wells under the drill.

## Assessments

| Company | Delinq. | Sale | Amt. |
|---|---|---|---|
| Adventure, Mich. | July 20 | ..... | $0.50 |
| Allah, Utah | Mar. 25 | Apr. 15 | 0.0025 |
| Basalt, Nev. | Mar. 8 | Apr. 6 | 0.003 |
| Beaver, Utah | Mar. 18 | Apr. 8 | 0.01 |
| Benton, Ida. | Apr. 15 | May 15 | 0.005 |
| Caledonia Silver, Nev. | Apr. 7 | Apr. 28 | 0.05 |
| Crown Point, Utah | Mar. 20 | Apr. 10 | 0.005 |
| Dennemora, Ida. | Apr. 5 | May 15 | 0.002 |
| Diam'dfield Black Butte, Nev. | Apr. 12 | May 18 | 0.01 |
| East Caledonia, Ida. | Mar. 21 | Apr. 10 | 0.01 |
| East Hercules, Ida. | May 1 | June 1 | 0.0015 |
| Echo, Ida. | Apr. 14 | May 15 | 0.002 |
| Emerald, Utah | Mar. 15 | Apr. 11 | 0.00½ |
| Eureka Dev. Utah | Apr. 10 | May 1 | 0.02 |
| Federal Ely, Nev. | Apr. 1 | May 1 | 0.005 |
| Federal Ely, Nev. | May 1 | June 4 | 0.005 |
| Flagstaff, Ida. | Mar. 20 | Apr. 15 | 0.002 |
| Friend, Ida. | Apr. 28 | May 20 | 0.002 |
| Great Bend, Nev. | Apr. 5 | May 8 | 0.01 |
| Howell, Utah | Apr. 15 | May 3 | 0.01 |
| Idaho-Nevada, Ida. | Apr. 7 | May 1 | 0.002 |
| Index, Ida. | Apr. 6 | May 6 | 0.0025 |
| International, Ida. | Mar. 16 | Apr. 10 | 0.002 |
| King David, Utah | ..... | ..... | 0.005 |
| Laciede, Ida. | Apr. 25 | May 15 | 0.003 |
| Mayflower, Ida. | Mar. 15 | Apr. 15 | 0.005 |
| Mountain Rose, Ida. | Mar. 8 | Apr. 8 | 0.001 |
| National Copper, Ida. | Mar. 25 | Apr. 22 | 0.01 |
| Nevada-Douglas | Apr. 17 | May 16 | 0.10 |
| Nevada Stewart, Ida. | Mar. 25 | Apr. 14 | 0.002 |
| North Bunker Hill, Ida. | Apr. 18 | May 20 | 0.002 |
| Ophir, Nev. | Mar. 22 | Apr. 12 | 0.05 |
| Paloma, Utah | Mar. 18 | Apr. 8 | 0.01 |
| Park Gold, Utah | Apr. 1 | Apr. 20 | 0.001 |
| Rhode Island, Ida. | Mar. 30 | May 15 | 0.002 |
| Rio Grand Grubstake, Nev. | Mar. 27 | Apr. 22 | 0.006 |
| Rockford, Ida. | Mar. 15 | Apr. 15 | 0.001 |
| Selma, Utah | Mar. 27 | Apr. 12 | 0.0025 |
| Silver Mt., Ida. | Feb. 17 | Apr. 15 | 0.002 |
| Summit Ex., Utah | Mar. 15 | May 1 | 0.01 |
| Sunset, Nev. | Mar. 27 | Apr. 29 | 0.01 |
| Tiberius, Ida. | Apr. 15 | May 15 | 0.001 |
| Tintic Standard, Utah | Mar. 15 | Apr. 10 | 0.005 |
| Tonopah Bonanza, Nev. | Apr. 3 | May 8 | 0.01 |
| Tono. Gypsy Qn., Nev. | Mar. 20 | Apr. 24 | 0.01 |
| Umatilla, Nev. | Apr. 17 | May 22 | 0.005 |
| Utah Metals, Utah | Mar. 11 | Apr. 15 | 0.001 |

## Stock Quotations

| SAN FRANCISCO | Apr. 3 |
|---|---|
| Name of Comp. | Bid. |
| Alta | .05 |
| Andes | .09 |
| Best & Belcher | .03 |
| Bullion | .01 |
| Caledonia | .30 |
| Challenge Con. | .05 |
| Confidence | .15 |
| Cons. Imperial | .01 |
| Con. Virginia | .18 |
| Gould & Curry | .02 |
| Hale & Norcross | .03 |
| Jacket-Cr. Ft. | .10 |
| Mexican | .19 |
| Occidental | .75 |
| Ophir | .28 |
| Overman | .04 |
| Savage | .05 |
| Seg Belcher | .02 |
| Sierra Nevada | .18 |
| Union Con. | .44 |
| Utah Con. | .01 |
| Belmont | 4.40 |
| Jim Butler | .95 |
| MacNamara | .07 |
| Midway | .23 |
| Mont.-Tonopah | .28 |
| North Star | .18 |
| Rescue Eula | .28 |
| West End Con. | .78 |
| Atlanta | .14 |
| Blue Bell | .01 |
| Booth | .19 |
| C.O.D. Con | .03 |
| Comb. Frac | .07 |
| D'field Daisy | .02 |
| Jumbo Extension | .83 |
| Pitts.-Silver Peak | .09 |
| Round Mountain | .71 |
| Sandstorm Kendall | .04 |
| Silver Pick | .07 |
| Central Eureka | .15 |
| Argo | .49 |
| Big Jim | 1.85 |
| Lazy Boy | .34 |
| Oatman Cres. | .40 |
| Oatman No. Star | .23 |
| Tom Reed | 1.90 |
| United Eastern | 4.18½ |
| United Western | .30 |

| LONDON | Mar. 21 |
|---|---|
| Alaska Tre'dwell | £6 12s 6d |
| Burma Corp. | 1 15 0 |
| Cam & Motor | 0 11 3 |
| Camp Bird | 0 7 0 |
| El Oro | 0 8 0 |
| Esperanza | 0 10 0 |
| Mexico Mines | 3 15 0 |
| Nechi, pfd. | 0 14 0 |
| Oroville | 0 14 0 |
| Santa Gert'dis. | 0 10 6 |
| Tomboy | 1 1 6 |
| Tough Oakes | 0 11 3 |

| SALT LAKE | Apr. 3 |
|---|---|
| Name of Comp. | Bidg. |
| Beck Tunnel | .25 |
| Black Jack | .13 |
| Colorado Mining | .25½ |
| Crown Point | .08½ |
| Daly-Judge | 7.20 |
| Emma Cop. | .64 |
| Gold Chain | .29 |
| Grand Central | .77 |
| Iron Blossom | 2.00 |
| Lower Mammoth | .06 |
| May Day | .14 |
| Opohongo | ‡.03½ |
| Prince Con. | 1.22½ |
| Seven Troughs | ‡.01½ |
| Silver King Coal'n | 3.12½ |
| Silver King Con. | 2.77½ |
| Sioux Con. | .24 |
| Uncle Sam | .06½ |
| Yankee | .30 |

| COLO. SPRINGS | Apr. 3 |
|---|---|
| Acacia | ‡.04½ |
| Cripple Cr'k Con. | ‡.007 |
| Doctor Jack Pot | .10½ |
| Elkton Con. | .29 |
| El Paso | .76 |
| Findlay | .05 |
| Gold Dollar | .01 |
| Gold Sovereign | .03½ |
| Golden Cycle | 2.16 |
| Isabella | .21½ |
| Jack Pot | .06½ |
| Jerry Johnson | ‡.05½ |
| Mary McKinney | .40 |
| Portland | 1.80 |
| Vindicator | 2.39 |

| TORONTO | Apr. 3 |
|---|---|
| Bailey | .05½ |
| Chambers Ferland | .22 |
| Coniagas | 4.50 |
| La Rose | .50 |
| Peterson Lake | .26½ |
| Right of Way | .04½ |
| Seneca Superior | .55 |
| T. & Hudson Bay | 25.00 |
| Temiskaming | .56 |
| Trethewey | .14 |
| Wettlaufer-Lor. | .08 |
| Dome Exten. | .37 |
| Dome Lake | .27 |
| Foley O'Brien | .53 |
| Hollinger | 27.50 |
| Imperial | ‡.02½ |
| Jupiter | .21 |
| McIntyre | .90 |
| Porcu. Crown | .68½ |
| Preston E. D. | .04½ |
| Vipond | .60 |
| West Dome | .25 |

| N. Y. EXCH. | Apr. 3 |
|---|---|
| Name of Comp. | Clg. |
| Alaska Gold M. | 20½ |
| Alaska Juneau | 10¼ |
| Am.Sm.&Ref.,com | 102½ |
| Am. Sm. & Ref., pf. | 113 |
| Am. Sm. Sec., pf. A | 93 |
| Am. Sm. Sec., pf. B. | 86 |
| Am. Zinc | 89½ |
| Anaconda | 87½ |
| Batopilas Min. | 2½ |
| Bethlehem Steel | 494 |
| Bethlehem Steel, pf. | 130½ |
| Butte & Superior | 92 |
| Chile Cop. | 22½ |
| Chino | 55½ |
| Colo. Fuel & Iron | 46 |
| Crucible Steel | 95½ |
| Dome Mines | 25½ |
| Federal M. & S. | 19 |
| Federal M. & S., pf. | 42 |
| Great Nor., ore., ctf. | 44½ |
| Greene Cananea | 50½ |
| Guggen. Exp. | 20¾ |
| Homestake | 127 |
| Inspiration Con. | 48½ |
| International Nickel | 48½ |
| Kennecott | 58½ |
| Lackawanna Steel | 77½ |
| Miami Copper | 38½ |
| Nat'l Lead, com. | 67 |
| National Lead, pf. | 114 |
| Nev. Consol. | 17½ |
| Ontario Min. | 8½ |
| Quicksilver | 3½ |
| Quicksilver, pf. | 4½ |
| Itay Con. | 24½ |
| Republic I&S, com. | 52 |
| Republic I&S, pf. | 109 |
| Sloss-Sheffield | 56 |
| Sloss-Sheffield, pf. | 97 |
| Tennessee Copper | 54½ |
| Utah Copper | 83½ |
| U. S. Steel, com. | 85½ |
| U. S. Steel, pf. | 116½ |
| Va. Iron C. & C. | 52 |

| N. Y. CURB | Apr. 3 |
|---|---|
| Alta Con. | .15 |
| Beaver Con. | .41 |
| Big Four | ‡.04 |
| Buffalo Mines | 1½ |
| Butte & N. Y. | 3½ |
| Butte C. & Z. | 8½ |
| Can. Cop. Corpn. | 1½ |
| Cashboy | .08 |
| Cerro de Pasco | 40½ |
| Con. Ariz. Sm. | 1 11/16 |
| Con. Coppermines | 1½ |
| Con. Nev.-Utah | ½ |
| Dia. Black B. | .01 |
| First Nat. Cop. | 5½ |
| Florence | .42 |
| Goldfield Con. | .78 |
| Goldfield Merger | .13 |
| Hecla Min. | 4 11/16 |
| Howe Sound | 5½ |
| Kerr Lake | 4½ |
| Magma | 18½ |
| Majestic | 11/16 |
| McKinley-Dar-Sa. | .47 |
| Mines of Am. | 3½ |
| Mother Lode | .31 |
| Nevada Hills | .18 |
| New Utah Bingham | 3 |
| Nipissing Mines | 7½ |
| Oro | .04 |
| Ray Hercules | 5 |
| Rochester Mines | .72 |
| St. Joseph Lead | 16½ |
| Stand'd Oil of N.J. | ‡524 |
| Standard S. L. | 1½ |
| Stewart | 11/16 |
| Success | .78 |
| Tonopah | 6½ |
| Tonopah Ex. | 5½ |
| Tonopah Merger | ‡.55 |
| Tribullion | 1/16 |
| White Knob, pf. | 1½ |
| Yukon Gold | 2 |

| BOSTON EXCH | Apr. 3 |
|---|---|
| Name of Comp. | Bid |
| Adventure | 3½ |
| Ahmeek | 399 |
| Algomah | 1 |
| Allouez | 69 |
| Ariz. Com., ctfs. | 9½ |
| Bonanza | .35 |
| Butte Alex. Scott | ‡10½ |
| Butte-Balaklava | 3½ |
| Calumet & Ariz. | 74 |
| Calumet & Hecla | 555 |
| Centennial | 17 |
| Copper Range | 64½ |
| Daly West | 3½ |
| East Butte | 12½ |
| Franklin | 9½ |
| Granby | 90½ |
| Hancock | 15½ |
| Hedley | ‡22 |
| Helvetia | .40 |
| Indiana | 4½ |
| Island Cr'k, com. | 46 |
| Island Cr'k, pfd. | 89 |
| Isle Royale | 28½ |
| Keweenaw | 4½ |
| Lake | 17 |
| La Salle | 4½ |
| Mason Valley | 3 |
| Mass | 13½ |
| Mayflower | 3 |
| Michigan | 2½ |
| Mohawk | 99 |
| New Arcadian | 8½ |
| New Idria | 15½ |
| North Butte | 29½ |
| North Lake | 1 |
| Ojibway | 2 |
| Old Colony | 2½ |
| Old Dominion | 69 |
| Osceola | 94½ |
| Quincy | 95 |
| St. Mary's M. L. | 74½ |
| Santa Fe | 2½ |
| Shannon | 9½ |
| Shattuck-Ariz. | 36½ |
| So. Lake | 7½ |
| So. Utah | .43 |
| Superior | 17 |
| Superior & Bost. | 3½ |
| Tamarack | 53 |
| Trinity | 8½ |
| Tuolumne | .30 |
| U. S. Smelting | 69 |
| U. S. Smelt'g, pf. | 51½ |
| Utah Apex | 4½ |
| Utah Con. | 14 |
| Utah Metal | 10½ |
| Victoria | 3½ |
| Winona | 4 |
| Wolverine | 58 |
| Wyandot | 1½ |

| BOSTON CURB | Apr. 3 |
|---|---|
| Bingham Mines | 12½ |
| Boston Ely | .40 |
| Butte & Lon'n Dev. | .93 |
| Calaveras | 3 1/16 |
| Calumet-Corbin | .06 |
| Chief Con. | 1 1/16 |
| Cortez | .80 |
| Crown Reserve | .38 |
| Davis-Daly | 1 11/16 |
| Eagle & Blue Bell | 2½ |
| Houghton Copper | 2½ |
| Iron Cap Cop., pf. | 5½ |
| Mexican Metals | .45 |
| Mojave Tungsten | 4½ |
| Nat. Zinc & Lead | 3 |
| Nevada-Douglas | .85 |
| New Baltic | 2½ |
| New Cornelia | 15½ |
| Ohio Copper | .18 |
| Oneco | 1 |
| Raven Copper | .18 |
| Rex Cons. | .17 |
| Rilla | .85 |
| United Verde Ext. | 25 |

‡Last Quotations.

## Monthly Average Prices of Metals

### SILVER

| Month | New York | | | London | | |
|---|---|---|---|---|---|---|
| | 1914 | 1915 | 1916 | 1914 | 1915 | 1916 |
| January | 56.572 | 48.855 | 56.775 | 26.553 | 22.731 | 26.960 |
| February | 57.506 | 48.477 | 56.755 | 26.573 | 22.753 | 26.975 |
| March | 58.067 | 50.241 | 57.935 | 26.788 | 23.708 | 27.597 |
| April | 58.519 | 50.250 | ..... | 26.958 | 23.709 | ..... |
| May | 58.175 | 49.915 | ..... | 26.704 | 23.570 | ..... |
| June | 56.471 | 49.034 | ..... | 25.948 | 23.267 | ..... |
| July | 54.678 | 47.519 | ..... | 25.219 | 22.597 | ..... |
| August | 54.344 | 47.163 | ..... | 25.979 | 22.780 | ..... |
| September | 53.290 | 48.680 | ..... | 24.260 | 23.591 | ..... |
| October | 50.654 | 49.385 | ..... | 23.199 | 23.925 | ..... |
| November | 49.082 | 51.714 | ..... | 22.703 | 25.094 | ..... |
| December | 49.375 | 54.971 | ..... | 22.900 | 26.373 | ..... |
| Year | 54.811 | 49.694 | ..... | 25.314 | 23.675 | ..... |

New York quotations cents per ounce troy, fine silver; London, pence per ounce, sterling silver, 0.925 fine.

### COPPER

| Month | New York | | London | | | |
|---|---|---|---|---|---|---|
| | Electrolytic | | Standard | | Electrolytic | |
| | 1915 | 1916 | 1915 | 1916 | 1915 | 1916 |
| Jan. | 13.641 | 24.008 | 60.756 | 88.083 | 65.719 | 116.17 |
| Feb. | 14.394 | 26.440 | 63.494 | 102 667 | * | 133.167 |
| Mar. | 14.787 | 26.310 | 66.152 | 107.714 | * | 136.000 |
| April | 16.811 | ..... | 75.096 | ..... | * | ..... |
| May | 18.506 | ..... | 77.600 | ..... | * | ..... |
| June | 19.477 | ..... | 82.574 | ..... | 95.333 | ..... |
| July | 18.796 | ..... | 76.011 | ..... | 91.409 | ..... |
| Aug. | 16.941 | ..... | 68.673 | ..... | 82.333 | ..... |
| Sept. | 17.502 | ..... | 68.915 | ..... | 85.250 | ..... |
| Oct. | 17.686 | ..... | 72.601 | ..... | 88.000 | ..... |
| Nov. | 18.627 | ..... | 77.744 | ..... | 93.273 | ..... |
| Dec. | 20.133 | ..... | 80.773 | ..... | 100.43 | ..... |
| Year | 17.275 | ..... | 72.532 | ..... | ..... | ..... |

### TIN

| Month | New York | | London | |
|---|---|---|---|---|
| | 1915 | 1916 | 1915 | 1916 |
| January | 34.260 | 41.825 | 156.550 | 175.548 |
| February | 37.415 | 42.717 | 176.925 | 181.107 |
| March | 48.426 | 50.741 | 180.141 | 193.609 |
| April | 47.884 | ..... | 166.225 | ..... |
| May | 38.790 | ..... | 162.675 | ..... |
| June | 40.288 | ..... | 167.636 | ..... |
| July | 37.423 | ..... | 167.080 | ..... |
| August | 34.389 | ..... | 151.440 | ..... |
| September | 33.125 | ..... | 152.625 | ..... |
| October | 33.080 | ..... | 151.554 | ..... |
| November | 39.224 | ..... | 167.670 | ..... |
| December | 38.779 | ..... | 167.000 | ..... |
| Av. year | 38.590 | ..... | 163.960 | ..... |

### LEAD

| Month | New York | | St. Louis | | London | |
|---|---|---|---|---|---|---|
| | 1915 | 1916 | 1915 | 1916 | 1915 | 1916 |
| January | 3.729 | 5.921 | 3.548 | 5.826 | 18.606 | 31.167 |
| February | 3.827 | 6.246 | 3.718 | 6.164 | 19.122 | 31.988 |
| March | 4.053 | 7.136 | 3.997 | 7.375 | 21.883 | 34.440 |
| April | 4.221 | ..... | 4.142 | ..... | 21.094 | ..... |
| May | 4.274 | ..... | 4.182 | ..... | 20.347 | ..... |
| June | 5.932 | ..... | 5.836 | ..... | 25.170 | ..... |
| July | 5.659 | ..... | 5.531 | ..... | 24.611 | ..... |
| August | 4.656 | ..... | 4.520 | ..... | 21.946 | ..... |
| September | 4.610 | ..... | 4.490 | ..... | 23.151 | ..... |
| October | 4.600 | ..... | 4.499 | ..... | 23.994 | ..... |
| November | 5.155 | ..... | 5.078 | ..... | 26.278 | ..... |
| December | 5.355 | ..... | 5.266 | ..... | 28.807 | ..... |
| Year | 4.673 | ..... | 4.567 | ..... | 22.917 | ..... |

### SPELTER

| Month | New York | | St. Louis | | London | |
|---|---|---|---|---|---|---|
| | 1915 | 1916 | 1915 | 1916 | 1915 | 1916 |
| Jan. | 6.386 | 16.915 | 6.211 | 16.745 | 30.844 | 89.810 |
| Feb. | 8.436 | 18.420 | 8.255 | 18.260 | 39.819 | 97.762 |
| Mar. | 8.541 | 16.846 | 8.360 | 16.676 | 44.141 | 95.048 |
| April | 10.012 | ..... | 9.837 | ..... | 49.888 | ..... |
| May | 14.781 | ..... | 14.610 | ..... | 68.100 | ..... |
| June | 21.208 | ..... | 21.038 | ..... | 100.614 | ..... |
| July | 19.026 | ..... | 18.856 | ..... | 97.250 | ..... |
| Aug. | 12.781 | ..... | 12.611 | ..... | 67.786 | ..... |
| Sept. | 13.440 | ..... | 13.270 | ..... | 67.841 | ..... |
| Oct. | 12.800 | ..... | 12.596 | ..... | 66.536 | ..... |
| Nov. | 15.962 | ..... | 15.792 | ..... | 88.409 | ..... |
| Dec. | 15.391 | ..... | 15.221 | ..... | 89.400 | ..... |
| Year | 13.230 | ..... | 13.054 | ..... | 67.553 | ..... |

New York and St. Louis quotations, cents per pound, London, pounds sterling per long ton. * Not reported

### PIG IRON IN PITTSBURGH

| Month | Bessemer‡ | | Basic‡ | | No. 2 Foundry | |
|---|---|---|---|---|---|---|
| | 1915 | 1916 | 1915 | 1916 | 1915 | 1916 |
| January | $14.59 | $21.60 | $13.45 | $18.78 | $13.90 | $19.70 |
| February | 14.55 | 21.16 | 13.45 | 18.93 | 13.90 | 19.51 |
| March | 14.55 | 21.81 | 13.45 | 19.20 | 13.95 | 19.45 |
| April | 14.55 | ..... | 13.45 | ..... | 13.95 | ..... |
| May | 14.61 | ..... | 13.60 | ..... | 13.83 | ..... |
| June | 14.70 | ..... | 13.67 | ..... | 13.77 | ..... |
| July | 14.94 | ..... | 13.91 | ..... | 13.68 | ..... |
| August | 16.01 | ..... | 15.31 | ..... | 14.75 | ..... |
| September | 16.86 | ..... | 15.95 | ..... | 15.70 | ..... |
| October | 16.95 | ..... | 15.96 | ..... | 15.80 | ..... |
| November | 17.57 | ..... | 16.47 | ..... | 17.20 | ..... |
| December | 19.97 | ..... | 18.44 | ..... | 18.95 | ..... |
| Year | $15.82 | ..... | $14.76 | ..... | $14.95 | ..... |

‡As reported by W. P. Snyder & Co.